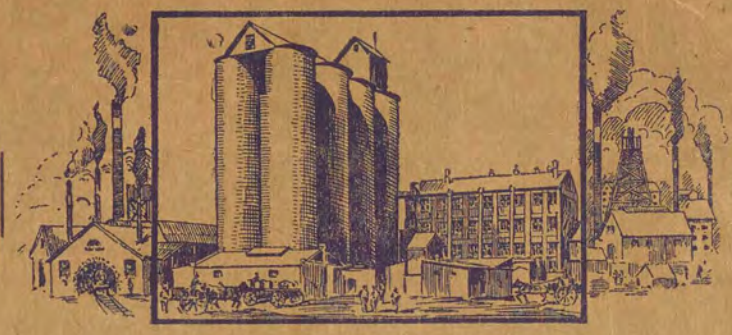

Industrial Development in South Africa

PRINTED IN SOUTH AFRICA AT
THE GOVERNMENT PRINTING AND STATIONERY OFFICE, PRETORIA.
1927

R. 905—8/10/26—5,000—(S. 4075).

INDUSTRIAL DEVELOPMENT
IN
SOUTH AFRICA

COMPILED BY

THE DEPARTMENT OF MINES AND INDUSTRIES

IN COLLABORATION WITH

THE SOUTH AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION

INQUIRIES MAY BE ADDRESSED TO—

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OR TO

The Board of Trade and Industries,
Union Building,
PRETORIA, SOUTH AFRICA

PRETORIA
THE GOVERNMENT PRINTING AND STATIONERY OFFICE
1927

CONTENTS.

NOTE.—A detailed index of the contents will be found at the end of this volume.

INTRODUCTION.

By H. WARINGTON SMYTH, C.M.G., M.A., LL.M., F.G.S., M.Inst.M.M.
(late Secretary for Mines and Industries).

THE object of this book is to give an up-to-date review of the possibilities of the Union of South Africa as an industrial country. Since the middle period of the War, when this country in common with others was thrown to a very large extent on its own resources, an immense development has taken place in the direction of the utilization of the raw products and natural resources within its borders, and it has become self-supporting in many important lines of industry to an extent that was not thought possible a few years ago.

The Department of Mines and Industries, with the assistance and advice of the Advisory Board of Industry and Science, has carried out a fairly exhaustive survey of the natural resources and the industrial facilities which are known and which appear capable of development in the Union, and the following pages give a summarized review of the position, with references to the authorities from which information on the various subjects is obtainable in greater detail.

Commencing as an agricultural country, South Africa entered upon a period of transition as a result of the discovery of diamonds at the spot that is now Kimberley in 1870, which event, followed by the discovery of the Witwatersrand goldfields and the gradual development of the extensive coal areas of the eastern Transvaal and northern Natal, inaugurated the second or "mineral" era of South Africa's economic growth. The new era was revolutionary in its effect on the form and character of the existing white civilization. It made possible a more rapid development economically, and in point of population, than could ever have occurred under the old agricultural régime. It created the modern commercial community, and it built up transportation systems on road and rail.

It was the middle period of the Great War which brought South Africa to the commencement of the third or the "industrial" chapter of its development, in which, for the first time, the conversion of the available raw products of the country into manufactured products has been commenced on an important economic scale.

A study of the map of the Southern Hemisphere shows that the Union of South Africa is so situated as to be in a remarkably advantageous position as a manufacturing and distributing centre in regard not only to the greater portion of the African Continent, but also to such markets as the South American, the East Indian, and the Australasian, and at the close of the War its activities in these directions showed promise of considerable extension.

The development of South Africa since the beginning of the "mineral" era undoubtedly owes a great deal to the presence of its native races, who under the direction of the incoming white races, have done most of the heavy work necessary in the development of an industrially new country. The presence of these races confers certain advantages on the country in regard to the cost of ordinary unskilled forms of labour, although at the same time it undoubtedly complicates the social problems of the country to an enormous extent. In considering the future development of industry in the

country, the native labour factor will exercise a great and, if properly guided, a beneficial influence, and must be kept in mind.

The following pages are intended more especially for those who contemplate the possibility of investing capital and establishing branch industries in areas of the globe outside Europe, where the supply of raw materials necessary for their industry is satisfactory, and the geographical position and labour conditions are suitable.

Hitherto, South African imports have been mainly manufactured goods, and her exports raw materials in the form of mineral products (gold, coal, and diamonds) and pastoral and agricultural products. The country has suffered, like most of the world, from the depression following the War, and industrial development, to find employment for the rising generation and to supply its own needs, is necessary, both in its own interests and those of the British Commonwealth. In this development the aid of British manufacturers will be of the utmost value in the direction of the establishment of branch factories in the Union, so that the requisite technical and factory skill and experience, together with capital, and that probity in business which has characterized British trade traditions in the past and to which every nation bears witness may be introduced, to assist South Africa in its development.

The existing large areas of coal in the Transvaal and northern Natal will, no doubt, become centres of industrial development and population, and will supply the essential needs for the establishment and development of the basic iron industry with its subsidiary manufactures, as well as cheap power for industrial purposes, including the important products obtained through the fixation of atmospheric nitrogen.

Experience has shown that in a new country haphazard methods are fatal to permanence in industry, and every effort has been made by the Department in the course of its surveys of industrial questions to base the estimates of the country's potentialities on scientific methods of investigation, and to assume scientific methods of development and control in manufacturing operations.

It is especially true in these days of mass production and of competitive trade, that scientific investigation of the occurrence and properties of natural resources and scientific supervision of productive operations are the absolutely essential hand-maidens of sound industrial growth.

In attempting to give due prominence to the scientific aspects of the inquiries it has undertaken, the Department has invariably found that the discussion of the economic aspects cannot be omitted, though in the past there has been a too frequent tendency to overlook them in the starting of new industrial schemes. In the study of industrial questions the mere statement of the scientific side of the case is insufficient without due recognition of the economic and practical side of the problem.

In the present book it has been found necessary, in order to give a fair picture of the country's industrial potentialities, to proceed to the consideration of the possible economic and industrial development which may be expected to occur in the future, and to deal to some extent with the secondary and by-product industries, which can and which although apparently somewhat remote at the present moment, must in the ultimate interests of the whole community be built up as a result of the development of the primary coal and other industries.

No less important to all industrial effort is the careful study of the possible markets upon which the manufacturer can rely for the export trade, which is so essential to all main lines of industry. This aspect of the position is receiving active consideration at the present time, and the Union of South Africa has now its Trade Commissioners in London, East Africa, on

the Continent of Europe, and in the United States of America (including Canada).

The Board of Trade attached to the Portfolio of Mines and Industries, advises the Government on tariffs and other methods of direct assistance and encouragement of local industries, and deals with commercial questions.

The Labour Department is intimately concerned through its Apprenticeship, Wages Board, and Factory Divisions, with every step of industrial activity. But slight reference need be made to these to show that the general features of South African industrial policy is to secure to industry fair conditions, and to competent tradesmen fair wages and good conditions of employment.

It may be added that the policy generally accepted includes municipal encouragement, cheap power, reasonable protection where labour conditions are satisfactory, and transport rates, which, it is believed, will become increasingly favourable to industrial enterprise.

CHAPTER I.

THE OUTLOOK FOR INDUSTRIALISM IN SOUTH AFRICA.*

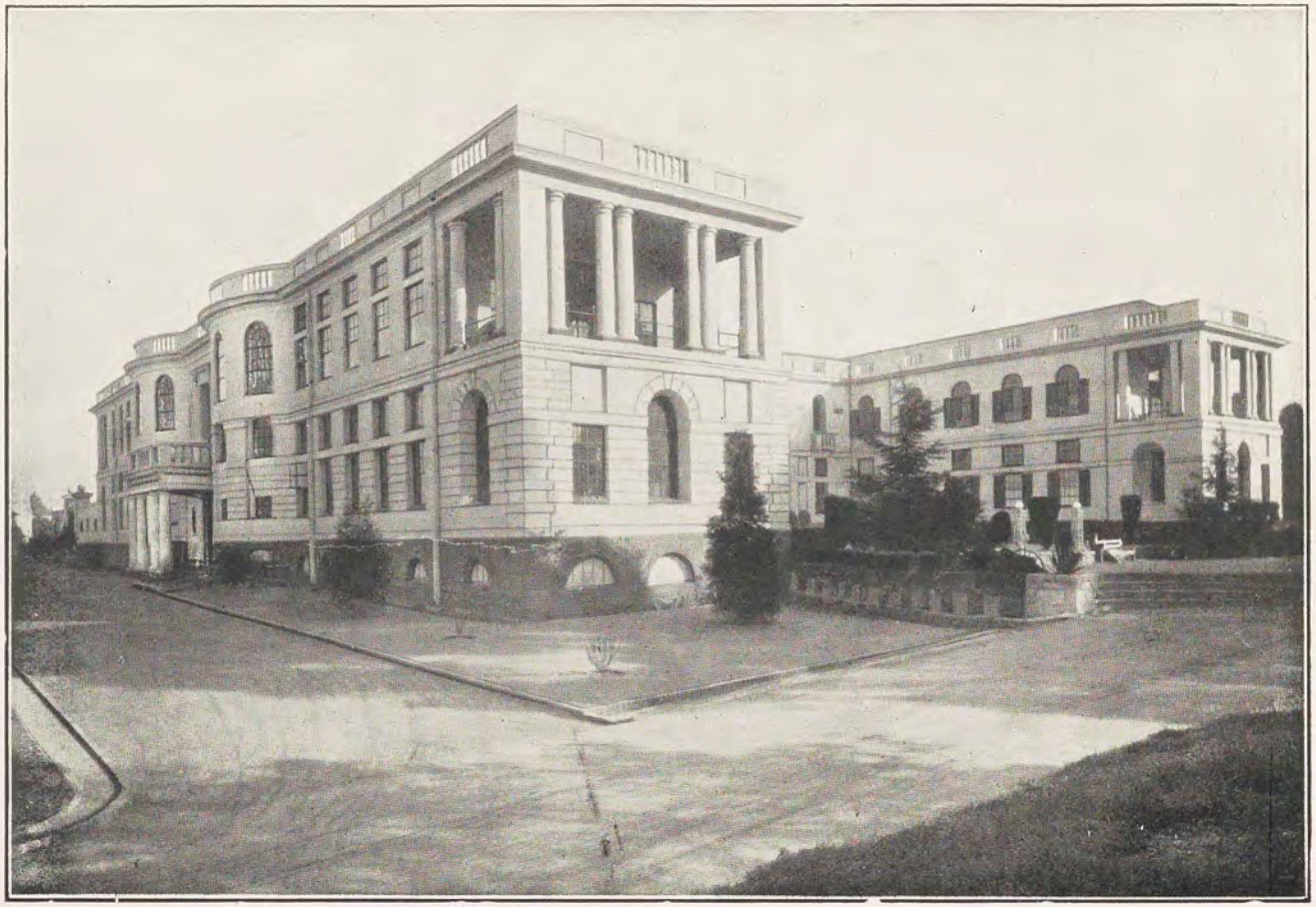
THE importance of South Africa is to be measured dynamically rather than statically. Hitherto, its growth has been slow compared with that of several other countries of the New World. Nevertheless, it has been sufficiently rapid to make South Africa a problem in looking into the future, so that no one would now care to assert categorically that South Africa would not one day carry a population as large as that of one of the chief states of Europe, and those who think it certain that this cannot be for many generations are fewer than they were. South Africans believe that their country is a great wheel going up hill, and that those who attach themselves to it will be carried up far and fast. The attempt will here be made to state the main facts which have to be considered in estimating the industrial future of the country.

South Africa is kept back by the smallness of its population, which makes manufacture difficult in an age of large scale production and cheap transport. We have not yet half the white population which the United States had at the time of the Declaration of Independence, and the first settlement of a white race in South Africa was made not more than half a century after that in North America. Moreover, our small population is scattered over the whole country, whereas, at the time of the American Revolution, the American colonies were comparatively compact. Taking the size of the population, the extent of the territory occupied, the lowering of costs by mass production, and the great cheapening of transport in the last century and a half, it will be seen that we are very far indeed from the position attained by the American colonies even under the old régime. Nor must it be forgotten that it was not till well on in the nineteenth century that the United States became a considerable manufacturing country. Still, there is much to be remembered on the other side. If it is true that the United States did not become a great manufacturing country till late in the nineteenth century, it is also true that the iron industry of the American colonies most seriously threatened that of Great Britain in the middle of the eighteenth century, and that both New South Wales and Victoria developed considerable industrial activity under different fiscal systems with populations considerably smaller than that of South Africa to-day. Above all, an examination of the facts in regard to our population will instil doubt into the confidence of pessimism.

Our Population.

The white population of the Cape Province was 182,000 in 1865, when the first census was taken. By 1926 it had increased to 706,000. That of Natal grew from 47,000 in 1891 to 159,000 in 1926; that of the Transvaal from 119,000 in 1890 to 609,000 in 1926; and that of the Orange Free State from 61,000 in 1880 to 203,000 in 1926. As between the provinces, the comparative rate of increase as stated in these figures is affected by the annexation of two Transvaal districts by Natal in 1903, and there have

* Written for the first edition by Prof. H. E. S. Fremantle, and revised for the second edition by the Editor.



THE SOUTH AFRICAN INSTITUTE OF MEDICAL RESEARCH, JOHANNESBURG.

View of the National Botanic Gardens, Kirstenbosch, Capetown.

been other annexations, which, however, would not greatly affect the figures quoted. They show a rate of increase throughout the whole country which augurs well for the future. In 1806, when the Cape was finally occupied by the British, the white population was estimated at about 26,000. In 1904, when the first simultaneous census was held in the four colonies which now comprise the Union, the white population was 1,117,000, and in 1926 it was 1,677,000. In addition to this, there were 24,000 white persons in the former German territory in South-West Africa, 6,000 in the three protectorates of Bechuanaland, Basutoland, and Swaziland, and 39,000 in Southern Rhodesia, the white population of which in 1904 was less than 13,000. Taking British South Africa as a whole, we find a total white population which is already considerable and the history of which warns the spectator that he must be prepared for a sudden and rapid start forward at any time.

Immigration of Europeans has not in recent years been large, but is at the rate of something like 7,000 a year, and in 1921* there were 243,000 of our white people who had been born outside South Africa. Among our white people the birth-rate has fallen, but is still over 27 per thousand, and is as high as in any western European country and considerably higher than in Australia or the United States. On the other hand, the death-rate is extremely low, being under 10 per thousand, the lowest rate in the world, with the single exception of New Zealand, lower than Britain, the United States, Australia, or Canada, over 40 per cent. lower than France, and not much more than a third of the rate in Russia. The result is that the natural increase of our white population is about the largest in the world, being 17 per thousand as compared with 16 for Canada, 15 for New Zealand and Russia, 14 for Scotland, 13¾ for England and Wales, 13 for Australia, and 9½ for the United States. The remarkable virility of our population is an immense asset, to which sufficient attention has not often been paid.

Extraordinary Educational Advances.

The numbers of our white population are, however, the least hopeful point in the situation. For many generations, owing to historic circumstances, a large section of our white people, coming from first-rate stock, have been seriously under-educated. Moreover, the new elements in our white population, coming here, with the bustle and fever of a mining camp, long tended to race their children through the schools into economic life, and were unduly slow to learn the lessons of experience in other countries that in the training of children, more haste means less speed. In regard to both these sections, the change in the last twenty years has been revolutionary. In our system of education, private schools have played, and still play, an honourable part, but it is on a far smaller scale than in the past, and it is no longer sufficient to vitiate to any great extent conclusions drawn from the number of children in our State and State aided-schools. In 1904 these numbered 114,000, or one in ten of the white population. In 1922 they numbered 331,000—over one in five of the white population.

This is surely an extraordinary if not unprecedented achievement for so short a period. Nor is it by any means all. Before the South African war in 1899 there was hardly anything which could pass as university education in the country. To-day we have four considerable and fairly well-equipped universities training together as many students as Oxford and growing at an almost phenomenal rate, so that the expectations of the most sanguine have been far surpassed, besides six other university colleges—all of them thoroughly justified by the demand for

* Figures of 1926 European Census not yet available.

them and all looking forward to taking rank as universities in the comparatively near future. In proportion to our population, our university students now number far more than in the best educated European countries and more than almost any other country, except the United States. Moreover, the rate of increase is probably unequalled. Furthermore, our students are to be found in universities all over the world, and already in more than one important matter South Africans have contributed to the scientific knowledge of mankind.

In other words, our people have rapidly travelled along the road by which they can reach their destiny as leaders in the upward effort of at least the southern half of the Dark Continent.

Whites as Leaders and Officers.

For it is as leaders and officers that the numbers of our white population must be appraised. It is less easy to estimate the progress of the non-European section of our people, because the gradual annexations of territory have added largely to their numbers; but the Director of Census of the Union states that between 1891 and 1921 * the non-European population increased from 2,779,000 to 5,409,000, notwithstanding a loss of half a million owing to the influenza epidemic in 1918. Of this total, 540,000 are of mixed race, 164,000 are Asiatics, and the rest are pure Bantu. The people of mixed birth, and to some extent the Asiatics also, have a considerable amount of development behind them and are in no sense barbarians. The Bantu are rising from barbarism, and in the opinion of most of those best qualified to judge, have more than their share of virility and promise. Taking the non-European people together, there was in 1891 about one in forty of the population in school, and the number has risen to about one in twenty-one in 1921. A college has been established, and a considerable number of native students go to foreign universities. It used to be reckoned that the non-European part of the population counts for about one-third of its numerical strength in the total economic value of the Union. It would be extremely difficult to get to a conclusion on this point which could be regarded with any confidence, nor is this the place to attempt it. In making comparisons between our population and that of countries with a uniformly developed people, it has to be remembered that if our non-European people count for less than the average in other countries because they form the rough labouring class, our European people count for more than the average, because they form the class leaders. Perhaps, for the purpose of estimating the economic potentialities of the country, we might assume that the total population of the Union is the equivalent of a population of some four and a half million in a purely European country. A comparison of the figures of trade and production in South Africa and Europe will tend to show that this estimate is certainly not exaggerated. It will be found that we use in general at least as much as 4,500,000 Europeans use, and in some very important matters—such as iron, where the element of distance adds to the demand very much more.

In his monograph on the Resources of South Africa, Professor Lehfeldt, of the Witwatersrand University, estimates that the "modal" income of the white people of South Africa is about equal to that of Australia, that the national income of the Union is about £137,000,000 a year, and that the total population is equivalent economically to about two million Europeans. Apparently, this is not inconsistent with the estimate in the text, as the modal income of Australians and South Africans is much higher than that of most European countries. The late Sir. R. Giffen

* Last enumeration of non European population.

estimated that the national income of South Africa in 1903 was £100,000,000 as against a national income of £1,750.000,000 for the United Kindom in the same year. Since then, South Africa has certainly advanced more rapidly than the United Kingdom.

A Problem in Development.

This, then, is the problem with which South Africa is confronted—how to proceed with a population perhaps equivalent to a population of four and a half million Europeans scattered over an area of 473,000 square miles, about four times the size of Great Britain and Ireland, more than twice the size of France, about twenty times the size of Holland and Belgium together, a population not very rapidly expanding by immigration, but with a very large and healthy rate of natural expansion, and with enormous possibilities as the undeveloped elements of the population rise in the order of civilization.

South Africa began as a settlement of market gardeners with the ships of the Dutch East India Company as its market. It has developed considerably as an agricultural country and finds markets for its wool, mohair, hides and skins, maize, and ostrich feathers in all parts of the world where such things are used. Our exports of these commodities account for some £13,000,000 of our annual income in ordinary years. The amount of these things used in the country, except in the case of maize, is comparatively trifling. In the case of other agricultural products the home market is more important, and the total agricultural output was valued in the last five years at an average of £77,734,000 a year, this being the price paid to the producer. Still, to agriculture, export is a matter of first-class importance.

The discoveries of diamonds, gold, and coal have given us a great mining industry, the output of which was valued in 1926 at £58,471,977 (preliminary figures). Except for coal, of the output of which about two-thirds was used in South Africa, almost the whole of our mineral output was exported.

Importance of our Manufacturing Industries.

Thus, very large industries have grown up mainly on the traditional colonial lines of producing food and raw materials for export. A century ago our exports were worth about £240,000 a year. Their annual value is now some £75,000,000. If these are compared with those of Great Britain it will be seen that our exports are about equal to those of a British population of four or five million. This necessarily implies a very considerable home market and would suggest to any competent observer the question whether the moment had not arrived for industrial expansion. It is not therefore surprising to find that, with the immense stimulus of the war, our manufacturing output has leapt up into very great importance, so that its gross value increased from £17,250,000 in 1911 to £40,500,000 in 1915-16, and £84,000,000 in 1924-25. This includes, of course, the price of the raw materials and also the output of repairing shops. It shows, however, that our manufacturing industries have become really important and set a problem for our statesmen. Till the other day they had to devise plans for stimulating our agriculture and mining, mainly for export. Now they have to work out schemes for carrying this on, and at the same time provide conditions to enable our manufacturing industries also to survive, grow, and flourish. The problem is a very difficult one, and it is hardly possible to hope that it can be surmounted without being very clearly grasped and deliberately grappled with. As it has arisen in very recent years, it is not surprising that national purpose has not yet fastened on it, and that,

in fact, its gravity is not at all generally appreciated. It is, perhaps, more surprising, as it is more satisfactory, that the Government has at at any rate shown signs of recognizing that a new problem has arisen and of feeling the necessity of finding a solution.

The problem is to enable our manufacturers to progress without injuring our agriculture and mining by making production dear. If this can be done, it, of course, follows that the growth of our manufactures will be to the advantage of our agriculture, and later on even of our mining, by providing them with markets—a truth insisted on by Adam Smith and all sane economists since. But in South Africa it may almost be said that the interests of industrialism cannot conflict with those of the older vocations because of the very smallness of our home market, which is the bane of our industries. Under modern conditions it is generally impossible for our industries to flourish with nothing but the home market to take its products. Many of our chief industries are already acutely aware of this, especially in the higher lines of production. Any industry can be established in any country if it is prepared to pay enough for it. But to manufacture iron and steel products, high-grade leathers, coal by-products, maize products, and many other things for our home market alone necessarily means such an increase of price as to raise the cost of production in the country as a whole and so strike a blow at the whole of our economic life. What our industries need, and what our agriculture and mining require that our manufacturing industries should have, is a set of conditions which will enable them to produce efficiently at a price low enough to secure them a place in the markets of the world. Protection may be, and in many cases probably is, necessary to this end, as the possession of the home market may be an essential condition of cheap production. But protection alone can never be the final solution of our national economic problem, for it can never give us the export trade we require.

Need for Cheap Production.

Our problem is to enable our manufacturers to produce cheaply and efficiently and to produce and sell their products on a large scale. It is a new problem and has not yet been definitely dealt with, faced, or generally recognized. The system which has grown up is mainly the product of concern with the affairs of a purely agricultural people. The interests of mining have always been wholly on the side of cheapness and the interests of much of our chief farming also, but for various reasons the old system has gone on, the great exporting farming industries having had far less to say in the formulation of policy than the industries near the oldest settlements in the Cape, which depend almost entirely on the home market and exist largely by protection, and the mining industry as a whole having been so prosperous that its general needs have not been much attended to. So we still collect a very large proportion of our revenue by indirect taxation, and have done nothing to devise a system of direct taxation suitable to the circumstances of our farmers; and in several other ways we show our obsession with the problems of the past and produce solutions appropriate to them to confront the new problems of another age, the chief of which is to enable our manufacturers to produce cheaply.

The problem is not less, but more, acute than it seems at first sight. For though we have, according to the calculations already mentioned, a home market equivalent to the respectable total of some 4,500,000 Europeans, this has to be a good deal qualified when we consider the distances separating the chief centres of population. Our population is less

than 15 per square mile as against 482 for Great Britain and Ireland and 665 for Belgium. The population of the United States is less than 36 per square mile and that of Australia and Canada less than 2, but in each of these cases there are immense tracts of unoccupied territory, and the population is far more concentrated than with us. In the Union you may travel nearly thirteen hundred miles to get from Capetown to Komatipoort on the borders of Mozambique, and nearly seven hundred to get from Durban to Mafeking, which is still south of the Bechuanaland Protectorate and five hundred miles from Bulawayo in the extreme south of Rhodesia. With much of its work inland, unlike Australia, Canada, and the United States, it is devoid of navigable rivers, and its long coast line is inhospitable. The problem of annihilating distance is in no other country so imperative as in South Africa.

National Services.

Though it cannot be said that any of our public or private institutions, except, perhaps, the Railway Administration, has exhibited much eagerness to face the special problems of the new situation, it may fairly be claimed for them that they have served us well in the old one. Our shipping is very largely controlled by a ring or conference, but it supplies us with regular service, and it cannot be said that the freight rates are unduly high. The development of the service to the East and round the whole coast of Africa has been delayed by the difficulties of obtaining freight. These are very great, as the tonnage of our exports now largely exceeds that of our imports. This is hardly a sufficient account for the delay in developing services to the East and round the continent, and it is surprising that the British lines should have allowed themselves to be forestalled by the Germans both before and since the war. But considering the extreme difficulties of the position, it must be admitted that the country has been well served by its shipping lines.

Much the same is to be said of the banks. The main objection to our banking system is that there is too much concentration in two institutions. These have in the main followed conservative lines of policy, and in the boom which followed the South African war especially, they showed more caution than was common at the time in this country. They have in general followed the tradition of English banking and have not attempted to perform the tasks carried out by the German bankers in financing manufacturing industries. But in a general way it cannot be denied that the country has been efficiently served by its banks, which are now in close touch with some of the greatest banking houses in England, and still greater stability has been provided by the institution of the Reserve Bank. There are probably few countries whose banking institutions more thoroughly possess and deserve the confidence of their people.

Post-War Problems.

On the whole, South Africa has been well served in the past. The new problems which have come with the growth of the country and with the war and its aftermath have, no doubt, proved bewildering to us, as they have to the whole world. They have been plainly stated here because it is desirable that it should be understood that they are clearly recognized by the Government, and that it is determined to do all that can be done to assist the economic progress of the country. The South Africa Act, which gave the Union its constitution, laid it down that the railways are not to be used as an engine of taxation. This meant at the time a considerable alleviation for inland producers and consumers, and very large reductions

have been made in the rates since Union. This provision secures the industries of the country against any attempt to depart from the policy of cheapening transport, as much as the condition of our railway finance permits. Our railways, being State institutions, pay no income tax. In lieu of a sinking fund, which is provided for by the general taxpayer, they pay interest on a comparatively small sum provided out of their current revenue for their own capital, but the interest on this is far less than the amount of the sinking fund in respect of the railway capital. As far as is possible with a State institution, therefore, everything has been done to secure cheap transport, and the utmost anxiety has been displayed by the railway authorities in this matter. But constant vigilance is necessary to secure for industry the best possible terms in view of everlastingly changing circumstances. There are, moreover, some special considerations which have to be faced in connexion with our railways. The authors of the constitution were naturally so engrossed with the circumstances of the time that they had little leisure to look forward to positions which had not then arisen. Determined to prevent the general revenue from using the railways as a taxing machine, they made an absolute division between railway and general finance, so that no one can cross the great gulf between them and pass from one to the other, not observing that they were blocking the thoroughfare not only to the tax collector but also to the doctor and the nurse. Not only are the railways debarred from contributing to the general revenue, but the general revenue is debarred from contributing to the railways. No doubt, this is in general desirable, but there may be cases where it is not in the public interest to charge full rates to infant industries, and, anyhow, such questions should be judged on their merits and not settled by the dead hand of a law designed to deal with something else. Fortunately, the last section of the South Africa Act prudently makes provision for amending all the rest if necessary, and this matter will no doubt receive attention in due time.

Oversea Markets.

The question of markets has been dealt with as it became insistent. We have had a trade commissioner in London since the time when Dr. Jameson was Prime Minister of the Cape Colony. During the past few years we have had trade commissioners stationed at Milan, New York, and Nairobi. The former has a representative at Hamburg. The Union also has honorary trade commissioners at Genoa Oslö, Rotterdam, Paris, and Karlsbad.

The Government's Active Interest.

The need for machinery to deal adequately with the problems of the present and the future has long been recognized by the Government. On the establishment of Union in 1910, a Minister of Commerce and Industry was appointed. This continued till 1912, when the office was amalgamated with that of the Minister of Mines under the title of Minister of Mines and Industries. This continues to the present day. There have, however, been considerable developments. In 1920 the Government appointed a scientific and technical adviser and director of industries. Dr. H. J. van der Bijl, a South African who had already won a name and position in the world of electro-technics in the United States, was appointed. On the establishment of the Electricity Supply Commission he became chairman, and was succeeded as scientific and technical advisor and director of industries by the present holder of that position, Dr. W. A. Caldecott, who had for many years been chief metallurgist to the goldfields of South Africa.

In 1921 a further step was taken by the appointment of a Board of Trade and Industries. There had been several previous attempts more or less in the same direction. An Industries Advisory Board was appointed in 1916 and a Scientific and Technical Committee in 1917, and the two were amalgamated in 1918 with the title of the Advisory Board of Industry and Science. On both the last bodies Rhodesia was represented. All these boards, including the Board of Trade and Industries, were appointed by Government Notice. The Advisory Board ceased to exist, its work being carried on by the Board of Trade and Industries.

Statutory powers were given to the Board by Act No. 28 of 1923. The term of office of the Board appointed under this Act expired in 1924, and a new Board was appointed with increased powers under Act No. 33 of 1924. Subject to the direction of the Minister, the functions and duties of the Board are to inquire into and advise the Government on all matters concerning the economic development of the natural resources of the Union and its industries and trade, and in particular on—

(*a*) the payment of bounties or other forms of State aid for industries;
(*b*) fiscal policy in so far as it bears on commerce and industry;
(*c*) the recasting and revision of the customs tariff;
(*d*) the removal of anomalies from time to time in the customs and excise tariffs;
(*e*) complaints or recommendations on the working of the customs and excise tariffs;
(*f*) combinations, trusts, monopolies, and restraints of trade tending to affect the general interest injuriously, especially by restricting production or maintaining or raising prices, and the prevention thereof;
(*g*) the dumping of imported goods whereby Union industries are likely to be unfavourably affected;
(*h*) the supply of raw materials, labour, and technical knowledge for industry, and the encouragement of the investment of capital in industry;
(*i*) transport and markets for the requisites and products of industries;
(*j*) the relation between factory, wholesale, and retail prices;
(*k*) commercial legislation;
(*l*) such other matters as the Minister may refer to it for report.

In course of time a further step was taken in the direction of co-ordinating and developing the industrial and commercial work of the Department, when the Board of Trade and Industries was instructed by the Hon. the Minister of Mines and Industries to "exercise the functions formerly entrusted to the Industries Division of the Department of Mines and Industries"; and to "act as the co-ordinating medium between the public and the Trade Commissioners for the Union in matters relating to overseas trade. In connexion with the latter instruction the Board is issuing a monthly *Commercial and Industrial Gazette*, in which are published the reports of the Trade Commissioners, as well as other reports on matters relating to oversea trade.

It will be seen that the Board is now entrusted with extremely arduous and important duties, and that it has the statutory powers necessary for carrying them out. First the Government and then Parliament have laid down with considerable minuteness the method of investigation which the Board is expected to perform, so that it would be difficult to specify any consideration which the Board is not expressly instructed to take into account.

The result of this is that, while the Board has to consider with the utmost care the interests of the general community, its primary business is to search out anything which can tend to the assistance of industry and recommend it to Government and Parliament, and in particular to consider whether any change is necessary or desirable in the interest of industry in regard to the customs and excise tariffs, both as a whole and as they directly bear on the affairs of particular industries; the provision of raw materials; the cost of transport; labour; the system of distribution; trusts and combines; markets in the Union, the neighbouring territories, and oversea; and generally all conditions affecting industry. It is not easy for individual manufacturers to deal with all the authorities concerned. The Board provides them with a friend at court, whose main business it is to assist them as far as is compatible with the public interest. The responsibilities resting on the Board are immense. If they are duly met it is difficult to see what more the Government could do to assist industries, as long as it carries out the recommendations of the Board, unless there are grave reasons for the contrary.

Many individual problems have to be dealt with in order to shape a policy suited to the circumstances of the new age in South Africa. The general problem has already been stated. It is to enable our manufacturers to manufacture for export, and so at the same time stimulate and increase the home market. To do this, the problem of reducing transport charges by the co-operation of the general with the railway authorities may soon have to be faced; the customs and excise tariffs must be thoroughly overhauled with the double object of giving each industry the direct assistance which the general interest of the whole community demands that it should have, and of reducing the cost of production and living as much as possible, and all possible markets must be exploited.

It should count for much that manufacturers know that they can apply to the Board to assist them in all these matters. The Board is at all times prepared to help manufacturers in obtaining information necessary for the prosecution of their work. Full information may now be obtained on general topics from the publications of the Statistical Department, and especially the "Official Year Book." Nor does the Government stand alone. All through the country the municipalities are eager to attract industrialists, and many of them offer special terms to manufacturers to come to their towns. Full information with regard to municipal affairs may be found in the "Official South African Municipal Year Book" (J. C. Juta & Co., Capetown).

Our Prospects.

The natural development of our home market is certain, unless some unforeseen calamity is destined to befall us, as our non-European people climb the ladder of civilization and take rank with Europeans as consumers, as the rapid natural increase of our European people makes itself felt, as this double increase calls for more services and enlarges the demand for labour, as immigration becomes more rapid and as the whole forward process is quickened by the development of our agricultural, mineral, and industrial exports.

Given cheapness of production, the possibilities of our developing an export trade are immense. The demands of Rhodesia, of South-West Africa, of Portuguese East and West Africa, of the Congo, and of British East Africa are bound to grow immensely as their populations develop, and it may well be that within a century these great territories may consume as much as 1000,000,000 Europeans do now. In regard to all of these South Africa has special advantages as a supplier, and in regard to some of them we may fairly claim that economically they can be reckoned as part of our

natural home market. Indeed, it is not too much to hope that something like a customs union may one day be established extending over the whole of Southern Africa, and possibly even farther. With this immense advantage and with very large supplies of coal and iron which Nature has denied to South America, it ought not to be impossible for us to win a place in the markets of the Far West. Nor can we despair of developing business on a great scale and to the advantage of all parties with the vast markets of India. The geographical position of South Africa is singularly fortunate. Its natural markets are enormous and have an infinite capability of expansion, and in some of them it is entrenched by distance. If we look forward a century and can suppose that the process of the emancipation of human nature and of its consequent development goes on throughout that period, it is difficult to put any bounds to our hopes for our country, or to refrain from envying the lot of future generations of South Africans, unless, indeed, there is a fiercer joy in building a house than in inheriting it.

CHAPTER II.

SOUTH AFRICA'S EXTERNAL TRADE.

A STUDY of the volume of trade in 1924 and its development since 1910—the year of Union—reveals some interesting facts. South Africa's most important supplier of merchandise is the United Kingdom, which in 1924 furnished 49 per cent. of the Union's imports. There has been a falling-off in the percentage of imports from the United Kingdom since 1910, when it stood at 59 per cent.; 64 per cent. of our imports, it may be added, are from British countries—representing, in 1924, over 37½ millions sterling.

The country that stands next in importance is the United States of America, which in 1924 supplied about 14 per cent. of our import requirements, or £8,785,500. Comparison with the 1910 returns reveals the notable fact that during ten years the United States' share of our import trade has grown from 7.8 per cent., a development for which the war was responsible. The Union's imports from outside the British Empire are drawn from over forty countries, but not one of these, except the United States, contributes more than about 5 per cent. of our total import requirements.

The total imports into the Union in 1926 amounted in value to £67,377,000 and in 1910 to £34,007,178.

We may now proceed to examine in more detail the trade of the Union, with which we are more intimately concerned.

In studying the development of our import and export trade during the period that has elapsed since the union of the four South African colonies took place, one is faced with the difficulty presented by the great changes in the prices of commodities since the outbreak of the European war. Comparisons of total values, therefore, convey little idea of the actual development that has taken place in trade, and in selecting figures for the purposes of study we are obliged to depart from the usual custom of using values when making trade comparisons, and have had to evade the pitfalls of prices by using quantities instead of values wherever comparisons of imports or exports between the two years have to be made.

In discussing the balance of trade, one must always bear in mind the elusive factor of "invisible exports." It is not proposed to discuss this factor here, and attention is called to it simply to remind readers that the figures about to be quoted do not necessarily represent with finality the economic position of the Union. As reflecting the balance of trade, pure and simple, in 1926 in comparison with 1910, however, they are of some interest.

In 1910 our imports amounted in value to £34,007,178, our exports to £54,684,038. The ratio of imports to exports was thus as 1 to 1.61. In 1926 imports came to £67,377,000, exports to £69,956,310—a ratio of 1 to 1.04.

The bulk of the Union's imports are manufactured articles. In a land, though full of raw materials, only now commencing its manufacturing career in real earnest, this fact is not surprising.

For the purposes of study, exports can conveniently be divided into four groups, viz.:—

(i) Products of the Mine.
(ii) Products of the Farm.
(iii) Products of the Factory.
(iv) Miscellaneous Commodities.

The last group includes the items in the returns "Removed to other States in the Customs Union."

Before proceeding to examine these groups individually, it will be of interest to note the changes that have taken place in the relative importance of these several groups.

In the following statements the total value of exports in each group in 1910 and 1926 respectively is shown, together with the proportion which each group bears to the whole of the exports in each year:—

	Total Value of Exports, 1910.	Per Cent. to Whole.
	£	
1. Metals and minerals	44,455,519	81·3
2. Farm products....	9,404,432	17·2
3. Manufactures.....	346.198	0·6
4. Miscellaneous.....	477,889	0·9
	£54,684,038	100·0

	Total Value of Exports, 1926.	Per Cent. to Whole.
	£	
1. Metals and minerals	45,749,177	65·40
2. Farm products....	21,739,167	31·08
3. Manufactures.....	2,445,698	3·50
4. Miscellaneous.....	22,268	0·02
	£69,956,310	100·0

The four groups may now each be dealt with separately, and here it will be possible in the case of individual items to make direct comparisons between the two years.

(i) *Products of the Mines.*

The items which are given separate mention in the customs returns are gold, silver, diamonds, coal, asbestos, copper ore, and regulus, copper matte, chrome ore, lead, manganese, tin, and zinc. The most important of these, of course, are gold, diamonds, and coal, which, taken together, account for over 97 per cent. of the total exports in the mining group. It may be of interest to add here that the gold exports account for 47 per cent. of the total exports of all commodities.

The following statement shows the relative importance in the mining group of the principal items in the export returns for 1910 and 1926:—

	1910.	1926.
	Per Cent.	Per Cent.
Gold.....	77·16	71·19
Diamonds.....	19·08	23·46
Coal.....	2·21	3·10
Other minerals.....	1·55	2·25
	100·00	100·0

(ii) *Products of the Farm.*

Exports of farm products of all kinds (including live animals), amounting in value to over 21 million sterling in 1926 and to not quite 9½ millions in 1910, were responsible in 1926 for over 30 per cent. of the total value of exports. In 1910 this group was responsible for a little over 17 per cent. of the total value of exports of all kinds, so that it has improved its position very considerably during the ten years. Wool, hides, and skins were the principal items in 1926, acounting between them for over 72 per cent. of the total value.

The following statement will indicate the relative importance (on the basis of values) of the six most important items on the list in each of the

two years, and to some extent the changes which have taken place since Union:—

EXPORTS OF FARM PRODUCTS.

	Proportion of Each Item to Total Exports for Group.	
	1910.	1926.
	Per Cent.	Per Cent.
Wool	40·7	58·17
Feathers	24·2	0·33
Hides and skins	13·7	12·05
Mohair	9·6	3·41
Maize	7·4	4·26
Bark and extract	2·3	4·22
Other products	2·1	17·56
	100·0	100·0

Two particularly striking items in this group of exports are wool and feathers. In 1910, 121,700,000 lb. of sheep's wool were exported, and in 1926, 211,695,494 lb. In 1910, £3,800,000 was received for wool exported, as against £12,645,851 in 1926. What the rise in the wool prices means to South Africa the foregoing figures indicate, and are worth recording. In the case of ostrich feathers, there is quite a different story to tell. From 741,000 lb. in 1910, the exports dropped to 147,674 lb. in 1926; and the value received fell from £2,272 800 to below £72,000. Prices, as everybody knows, came down.

Shipments of wattle bark in 1926 were about 107 per cent. heavier than in 1910, amounting to 90,095 tons.

Other changes which have taken place in the Union's exports of farm products are reflected in the following table:—

EXPORTS OF CERTAIN FARM PRODUCTS.

	1910.	1926.
Argol.....lb.	82,422	132,294
Buchu.....lb.	273,325	186,589
Fodder and forage.lb.	21,270,366	41,885,230
Kaffir corn.....lb.	4,705,100	9,051,374
Oats.....lb.	6,748,114	2,916,557
Eggs.....No.	614,242	30,059,462
Potatoes.....lb.	1,507,989	2,125,708
Horns.....lb.	633,942	982,909
Cotton.....lb.	—	8,080,399

(iii) *Products of the Factory.*

According to the Industrial Census returns, the factories of the Union produced £79,789,000 worth of merchandise, etc., of all descriptions in 1923-24.

The value added to the raw materials by process of manufacture or treatment was £40,586,000.

Before proceeding to a detailed examination of figures, it may interest readers to know what the Union is now exporting in the way of manufactures. The list of manufactured articles exported in 1926 includes the following:

South African Produce.

Bark and extract, bioscope films, blasting compounds, brushware, candles, caustic soda, coke, earthenware and china, furniture, glycerine, haberdashery, iron and steel manufactures, leather and leather goods, machinery, manures and fertilizers, oilcake, paper and paper manufactures, vehicles and parts, whale-oil, soap, starch, spirits (non-potable), stationery, tobacco and tobacco manufactures, whale residue, wood and timber, ale, beer, and stout, butter and substitutes, cheese, confectionery and jams, bran, hominy chop, maize, maize-meal, maize grits, samp, flour, fish (dried and preserved), fruit (canned, dried and preserved), meats (fresh, frozen, preserved, etc.), spirits (potable), sugar and sugar products, tea, wines, biscuits and bread candied peel, poultry food, vermicelli and marcaroni.

A study of the quantities of articles of food and drink exported shows some large increases. Striking develop-

ments are indicated in the following statement:—

EXPORTS OF CERTAIN ARTICLES OF FOOD AND DRINK.

	1910.	1926.
Ale and beer.....gals.	7,430	26,970
Butter.....lb.	13,602	259,039
Cheese.....lb.	30	113,248
Flour and meal, wheaten lb.	93,097	332,371
Fish, dried or preserved lb.	1,856,371	8,993,734
Fruit, dried or preserved lb.	41,811	11,227,606
Lard.....lb.	25	8,362
Meats, fresh or frozen..lb.	7,124	35,509,833
Meats, preserved and cured lb.	8,638	324,859
Spirits.....gals.	128,700	33,767
Sugar.....lb.	5,316,382	130,553,220
Sugar products, syrup, molasses, etc.....lb.	6,660,358	35,185,521
Wines.....gals.	49,471	168,856

Here are to be noted increases that, in some cases, such as butter, cheese, dried and preserved fruit and meats, run into many thousands per cent.; but quite a number of other items show big increases, as the following table indicates:—

EXPORTS OF CERTAIN OTHER MANUFACTURED COMMODITIES.

	1910.	1926.
Bark extract.....lb.	—	38,544,586
Manures.....lb.	—	10,322,123
Oil, whale.....gals.	879,852	2,963,000
Spirits, non-potable..gals.	950	451,776
Soap.....lb.	146,984	66,460
Tobacco and Cigarettes. lb.	182,197	852,624

The foregoing may be accepted as an index of the development that has taken place in the exports of manufactured goods other than food or drink; and the degree of development is highly satisfactory.

Overseas readers may regard the totals as small in comparison with the exports of older countries; but they should regard the volume of increase shown by comparison of the two years as one of the many indications of the manufacturing possibilities of the sub-Continent. Compared with the return of, say, twenty-five years hence, most of the export figures that have been quoted in this chapter will undoubtedly sink into insignificance; but they are of value now as indications of possibilities. They give point to the oft-reiterated fact that South Africa has great possibilities as a manufacturing country, because of her wealth of natural resources, and because of her favourable geographical position in relation to the markets to the north, east, and west. As indicated at the beginning of this chapter, the figures cannot be taken as a complete guide to the manufacturing progress of the country, for large quantities of South African made goods are now consumed locally; but they do show that South Africa has definitely embarked upon her inevitable career as a country exporting manufactured goods, and comparisons, such as have here been made, between 1910 and 1926, show how rapidly she is progressing in that direction.

CHAPTER III.

A SUMMARY OF MANUFACTURING PROGRESS.

MANUFACTURING industries have made notable progress in South Africa during the past ten years, and undoubtedly the abnormal conditions created all over the world by the European war were in a large measure responsible for this. It is not to be inferred from this, however, that the gradual disappearance of those conditions will necessarily have an adverse effect upon the activities of South African manufacturers. Many industries had already been soundly established before the war gave them a tremendous fillip. The abnormal conditions also provided the opportunity for the establishment and development of a number of other industries. Some of these may find themselves unable to continue when the conditions of the world's trade return to normal, although as to that it would be difficult to prophesy. The main point is that South Africa is now definitely on the threshold of her career as a manufacturing country. With a wealth of raw materials at her disposal, with a growing white population, and a great native population that is every year developing greater needs, and with important markets to the north, east, and west, there can be no turning back. Every year sees further progress, existing industries being extended and new ones begun.

Year or Period in which Operations Began.	Total No. of Factories started in that Year or Period.
Before 1890	505
1890–1899	615
1900–1909	1,645
1910–1915	1,608
1916	335
1917	401
1918	465
1919	747
1920	568
1921	116
1922	50
	7,055
1923 Decrease	26
TOTAL	7,029

Illustrating in a general way the growth of manufacturing industries, the figures in the preceding table show the periods in which the 7,029 factories in the Union were established.

The returns for 1922-23 are the latest available, and some of these factories may have ceased working, whilst others have come into existence. The net result, however, is that, whilst in 1916 there were 4,708 factories in existence in the Union, in 1923 there were 7,029, representing an increase in number of establishments of about 49 per cent.

In 1922-23 the value of the machinery, plant, and tools installed in these 7,029 factories was £29,588,000, and they employed 172,047 hands (of whom 61,296 were Europeans), paying out £19,186,334 in wages. They used £37,140,000 worth of raw materials (almost half of which was of South African origin), to the value of which they added over £37,000,000 by manufacturing process. The gross value of the output of these seven thousand odd factories was thus over £74,000,000.

The following table shows the value of materials divided up into seventeen classes used in the factories of the different Provinces of the Union in 1923-23:—

I.—VALUE OF MATERIALS USED IN FACTORIES, 1922–23, IN CERTAIN INDUSTRIAL CENTRES AND IN THE UNION.

Class of Industry.	Witwatersrand.	Cape Peninsula.	Durban.	Port Elizabeth.	Union.
	£	£	£	£	£
Raw material	421,253	140,599	315,464	15,082	1,134,664
ii. Stone, clay, etc.	227,926	36,790	25,432	955	423,580
iii. Wood	319,019	260,341	161,734	61,298	975,552
iv. Metals, engineering, etc.	2,967,042	839,140	880,988	68,629	5,930,511
v. Food, drink, etc.	3,452,036	3,431,525	1,732,107	640,690	15,577,019
vi. Clothing, textiles, etc.	502,413	377,880	178,649	36,793	1,329,636
vii. Books, printing, etc.	444,141	373,330	82,253	31,521	1,072,539
viii. Vehicles, etc.	173,373	95,376	47,415	11,873	607,632
ix. Shipbuilding, etc.	—	6,283	13,378	—	19,661
x. Furniture, etc.	228,739	263,884	79,006	56,686	673,335
xi. Chemicals, etc.	993,872	981,752	950,038	44,241	3,161,704
xii. Surgical instruments, etc. xiii. Jewellery, etc.	*25,263	5,733	7,382	1,648	46,618
xiv. Heat, light, and power	754,112	187,805	79,316	24,928	1,140,926
xv. Leather and leatherware	143,604	341,651	31,858	411,167	1,411,869
xvi. Building and contracting	1,092,067	594,960	618,311	149,961	3,535,033
xvii. Other industries	38,361	19,850	4,777	61	99,524
TOTAL £	11,783,221	7,956,900	5,208,108	1,555,533	37,139,803

In the next table is shown the value of the South African materials used in the factories of the Union. It will be noted that South African materials make up about 45 per cent. of the total of materials used in 1922-23:—

II.—VALUE OF SOUTH AFRICAN MATERIALS INCLUDED IN TABLE I, 1922–23.

Class of Industry.	Witwatersrand.	Cape Peninsula.	Durban.	Port Elizabeth.	Union.
	£	£	£	£	£
i. Raw material	419,727	134,896	238,161	6,791	1,021,922
ii. Stone, clay, etc.	118,039	12,946	9,939	448	177,591
iii. Wood	108,380	12,974	28,586	5,287	246,646
iv. Metals, engineering, etc.	127,840	34,753	36,040	2,596	259,674
v. Food, drink, etc.	3,070,568	2,295,063	1,245,967	279,904	12,533,112
vi. Clothing, textiles, etc.	21,701	23,653	7,363	775	64,083
vii. Books, printing, etc.	3,115	3,081	55	10	6,974
viii. Vehicles, etc.	22,380	18,224	3,820	615	104,108
ix. Shipbuilding, etc.	—	100	64	—	164
x. Furniture, etc.	6,930	8,491	4,562	4,131	25,684
xi. Chemicals, etc.	177,070	122,033	522,588	8,060	953,584
xii. Surgical instruments, etc. xiii. Jewellery, etc.	* 6,086	1,289	166	661	12,551
xiv. Heat, light, and power	28,355	28,561	12,949	12,775	99,328
xv. Leather and leatherware	112,173	242,783	15,948	275,566	995,370
xvi. Building and contracting	15,709	62,978	54,153	3,951	157,955
xvii. Other industries	21,839	1,083	200	—	24,018
TOTAL £	4,259,912	3,002,908	2,180,561	601,570	16,682,764

* Classes combined in industrial centres owing to small number of establishments concerned.

Table III shows the gross value of factory production in the Provinces of the Union from 1915-16 to 1922-23:—

III.—GROSS VALUE OF FACTORY PRODUCTION, 1915–16 TO 1922–23.

Year.	Cape of Good Hope.	Natal.	Transvaal.	Orange Free State.	Union.
	£	£	£	£	£
1915–16	14,616,427	9,655,505	14,266,643	1,886,307	40,434,882
1916–17	18,042,980	11,284,394	17,638,888	2,491,152	49,457,414
1917–18	22,647,248	13,754,356	21,781,402	2,623,904	60,806,910
1918–19	25,544,312	15,796,411	26,373,345	3,220,030	70,934,098
1919–20	33,157,026	21,978,325	33,225,833	4,552,660	92,913,844
1920–21	35,231,715	23,790,541	34,646,876	4,638,778	98,307,910
1921–22	28,301,757	18,519,810	28,674,085	3,950,647	79,446,299
1922–23	26,562,111	16,328,711	27,952,789	3,642,681	74,486,292

In Table IV the gross value of factory production for each class of industry for 1922-23 is shown. By deducting from the gross value of the output of factories the cost of materials used, the value added in the process of manufacture is obtained.

IV.—GROSS VALUE OF FACTORY PRODUCTION OF EACH CLASS IN CERTAIN INDUSTRIAL CENTRES AND IN THE UNION, 1922–23.

Class of Industry.	Witwaters-rand.	Cape Peninsula.	Durban.	Port Elizabeth.	Union.
	£	£	£	£	£
i. Raw material	459,207	192,730	381.795	58,230	1,514.583
ii. Stone, clay, etc	1,073,909	212.569	89.477	24,844	2,303.275
iii. Wood	600,864	489,721	328,558	111,622	1,865,778
iv. Metals, engineering, etc	6,533.065	1,838,997	1,748,955	158,074	13,238,061
v. Food, drink, etc	4,997,333	5,951,448	2,453,933	959,396	23,839,179
vi. Clothing, textiles, etc	1,101,246	821,563	344,353	91,908	2,847,980
vii. Books, printing, etc	1,433,803	1,182,100	359,752	131,084	3,820,714
viii. Vehicles, etc	474,366	231,450	138,214	33,202	1,593,044
ix. Shipbuilding, etc	—	17,191	35,456	—	52,647
x. Furniture, etc	441,984	547,832	175,037	103,197	1,386,320
xi. Chemicals, etc	1,673,984	1,688,501	1,741,659	77,562	5,534,316
xii. Surgical instruments, etc..	*80,794	27,563	17,566	11,231	154,742
xiii. Jewellery, etc					
xiv. Heat, light, and power	3,549,822	683,467	364,099	125,655	5,463,583
xv. Leather and leatherware	254,865	694,223	72,212	742,277	2,546,154
xvi. Building and contracting	2,559,123	1,311,066	1,327,252	353,252	7,801,126
xvii. Other industries	96,964	191,781	175,067	510	524,790
TOTAL £	25,331,329	16,082,202	9,753,385	2,982,044	74,486,292
	£	£	£	£	£
Average value of output per employee	444	515	472	421	433
Average value of output per white employee	1,155	1,445	1,461	997	1,215

* Classes combined in industrial centres owing to small number of establishments concerned.

Table V shows the value added to raw materials in process of manufacture, in the case of each class of industry in certain important industrial centres.

Particulars are also given as to the average value added (*a*) per employee, and (*b*) per white employee.

V.—Value Added in Process of Manufacture in Factories in Certain Industrial Centres and in the Union, 1922–23.

Class of Industry.	Witwatersrand.	Cape Peninsula.	Durban.	Port Elizabeth.	Union.
	£	£	£	£	£
i. Raw material	37,954	52,131	66,331	43,148	379,919
ii. Stone, clay, etc.	845,983	175,779	64,045	23,889	1,879,695
iii. Wood	281,845	229,380	166,824	50,324	890,226
iv. Metal, engineering, etc.	3,566,023	999,857	867,967	89.445	7,307,550
v. Food, drink, etc.	1,545,297	2,519,923	721,826	318,706	8,262,160
vi. Clothing, textiles, etc.	598,833	443,683	165,704	55,115	1,518,344
vii. Books, printing, etc.	989,662	808,770	277,499	99,563	2,748,175
viii. Vehicles, etc.	300,993	136,074	90,799	21,329	985,412
ix. Shipbuilding, etc.	—	10,908	22,078	—	32,986
x. Furniture, etc.	213,245	283,948	96,031	46,511	712,985
xi. Chemicals, etc.	680,112	706,748	791,621	33,321	2,372,612
xii. Surgical instruments, etc. xiii. Jewellery, etc.	*55,531	21,830	10,184	9,583	108,124
xiv. Heat, light, and power	2,795,710	495,662	284,783	100,727	4,322,657
xv. Leather and leatherware	111,261	352,572	40,354	331,110	1,134,285
xvi. Building and contracting	1,467,056	716,106	708,941	203,291	4,266,093
xvii. Other industries	58,603	171,931	170,290	449	425,266
Total £	13,548,108	8,125,302	4,545,277	1,426,511	37,346,489
	£	£	£	£	£
Average value added per employee	237	260	220	201	217
Average value added per white employee	618	730	681	477	609

* Classes combined in industrial centres owing to small number of establishments concerned.

CHAPTER IV.

LABOUR IN SOUTH AFRICA.

GENERALLY speaking, labour may be divided into three broad classes—skilled, semi-skilled, and unskilled; but there is probably no other country where the workpeople are also so clearly divided as in South Africa.

Skilled work in the Transvaal and Orange Free State is almost entirely in the hands of European workers. Semi-skilled work is principally done by coloured or native workers; whilst the heavy unskilled work is almost entirely performed by native labour. In the Cape Province and Natal a considerable portion of the skilled work is also done by coloured workers.

Conditions in the Union of South Africa vary to some extent in the different provinces, as they do in other countries, but there are also racial differences to be considered. In the Transvaal and Orange Free State there exists what is known as the "colour bar." In the past this was largely based on sentiment and public opinion, with the object of preserving the skilled work for white people only. This colour bar was also generally supported by the trade unions. In the coastal provinces, Natal and the Cape, there was not the same prejudice against employing coloured or native workers on any class of work. No colour bar existed, and some of the trade unions catering for highly skilled craftsmen, such as the Amalgamated Engineers' Union, the Typographical Union, and others, admitted coloured workers to membership.

Legislation adopted in 1926 enables the Government to issue certificates of competency to Europeans and certain classes of coloured workers employed as mine managers, mine overseers, mine surveyors, mechanical engineers, engine-drivers, miners entitled to blast, and others employed in, at, or about mines, works, and machinery. Particular classes of work may be restricted to Europeans and coloured workers, and duties and responsibilities may be prescribed by regulation. The exclusion of natives from these prescribed classes of work establishes by law what is known as the "colour bar."

In European countries a wrong impression often exists regarding the abilities of skilled craftsmen available in South Africa. While it is true that an ever-increasing number of artisans are being trained in South Africa, the majority of skilled workers now in the country have come from overseas; attracted by the higher wages and the wider field, many of the most highly skilled workers have migrated here. Employers may feel assured that they can obtain skilled craftsmen who will take second place to none as regards ability and general knowledge. On the average their experience has been greatly improved by handling all classes of machinery from every manufacturing country in the world.

Although in the Transvaal and Orange Free State practically all the skilled, and a large portion of the semi-skilled work is performed by Europeans, there are a few occupations where coloured men and women, or even natives, do the work. On skilled or semi-skilled work of a mechanical nature the efficiency of the coloured and native workers is good, and, on the whole, they make excellent workmen.

The question of wages is, of course, one of the most important factors, and very often determines the class of labour to be employed, and the following tables show the rates of wages paid

throughout the Union to the principal classes of skilled artisans as at 30th June, 1926:—

ENGINEERING—48 HOURS PER WEEK.

Blacksmiths, boilermakers, electricians, fitters, millwrights, moulders, patternmakers, and turners:—

		Per Hour. s. d.
Cape Province.....	Cape Peninsula....	2 6
	Port Elizabeth....	2 6
	East London.....	2 6
	Kimberley.....	2 6
Natal.....	Pietermaritzburg...	2 6
	Durban.....	2 6
Transvaal.....	Pretoria.....	2 8¼
	Johannesburg and Witwatersrand..	2 7½
Orange Free State	Bloemfontein.....	2 6

BUILDING TRADES—44 HOURS PER WEEK.

Bricklayers, carpenters, masons, plasterers, plumbers, etc.:—

		Per Hour. s. d.
Cape Province.....	Cape Peninsula....	2 9
	Port Elizabeth....	2 9
	East London.....	2 9
	Kimberley.....	2 9
Natal.....	Pietermaritzburg...	2 11
	Durban.....	3 1
Transvaal.....	Pretoria.....	3 4
	Johannesburg and Witwatersrand..	3 4
Orange Free State	Bloemfontein.....	3 3

Painters are paid from 2d. to 5d. less per hour than the above rates.

PRINTING TRADES.

Area and Branch.	Wages per Week.				Hours per Week.			
	Journeymen, other than Typesetting Machine Operators.		Operators on Typesetting Machines.		Journeymen other than Typesetting Machine Operators.		Operators on Typesetting Machines.	
	Day. s. d.	Night. s. d.	Day. s. d.	Night. s. d.	Day.	Night.	Day	Night.
Area 1.								
Capetown, East London, Maritzburg, Port Elizabeth	122 6	134 9	134 9	148 3	46	40	43	40
Area 2.								
Kimberley, Potchefstroom	132 6	145 9	145 9	160 3	46	40	43	40
Area 3.								
Bloemfontein	142 6	156 9	156 9	172 6	46	40	43	40
Durban	142 3	156 6	156 6	172 0				
Area 4.								
East Rand, Johannesburg, Pretoria	152 6	167 9	167 9	184 6	46	40	43	40
Area 5.								
Rhodesia	172 6	189 9	189 9	208 9	46	40	43	40

The wages of semi-skilled labour approximates, roughly, from 50 per cent. to 75 per cent. of the rates paid to skilled workers.

In Natal and the Cape, skilled coloured workers in most cases are paid slightly lower rates than skilled Europeans for the same class of work.

In the case of coloured and native labourers employed as operators in factories, on the mines and railways, or on unskilled work, the wages paid are very low when compared with the rates paid to Europeans. Although obvious to the South African, these differences require some explanation to the oversea reader. In South Africa the European worker lives at a standard equal, and often superior, to that of his oversea confrère. The coloured man lives on a much lower standard.

Natives employed on mines are housed in what are called "compounds," and the employer feeds them and also provides medical attention. The cost of keeping natives in this manner works out at approximately 1s. 1d. per native per day. The staple food of the native consists of porridge made from ground maize, called "mealie-meal." This porridge is eaten without milk or anything added. In addition to his keep, the native is paid from 2s. to 2s. 6d. per day.

In other avenues of employment the conditions of native workers vary with circumstances; some employers provide housing accommodation only in addition to pay, while others pay in wages alone and leave the native free to make his own arrangements regarding food and accommodation.

As in the case of white workers, the wages vary throughout the country, but may be taken approximately as follows:—On the mines, with food and housing provided at a cost of 1s. 1d. per day, the native is paid an average of 2s. 3d. per day in addition. On the South African Railways natives are paid an average of 2s. 3d. per day plus food and quarters, and approximately 2s. 9d. without food or quarters. In other employment, with no food or housing, the wage runs from 2s. to 3s. 6d. per day. Natives employed as farm labourers are paid about 30s. per month, and usually build their own huts or shelters.

During the past decade employers and employees have formed associations or trade unions, and the principle of collective bargaining as to working conditions has been fairly well established, particularly in the larger centres.

Joint boards, representative of employers and employees in most of the principal industries, were established during the war period with, on the whole, very satisfactory results. The most outstanding was the joint board for the printing industry, which was representative of all the provinces in the Union of South Africa.

In 1924 the Industrial Conciliation Act was passed. Under this Act provisions were made for establishing industrial councils, thus practically legalizing the system of joint boards.

Where agreements are arrived at regarding working conditions and relations between employers' and employees' organizations, such agreements may be applied to all employers and employees in the area for which the industrial council is considered representative and are enforceable in the law courts.

National agreements regarding wages and working conditions have now been established in the printing, building, furniture, and leather industries. A considerable number of local agreements have also been entered into and further agreements, national and local, are being negotiated.

Provisions are also made for the appointment of conciliation boards, where no industrial council exists, to deal with specific disputes. Agreements arrived at by such boards may also be extended and given the full force of law.

Factory legislation, which applies uniformly throughout the Union, provides for inspection, registration, hours of work, and sanitary and hygienic conditions, etc. Legislation also exists for the regulation of apprenticeship to certain trades by the appointment of committees representing employers and employees. These committees advise the Minister con-

cerned, and when he is satisfied regarding any proposals made, such conditions are published as regulations and thus become binding. Thus by these social enactments employees' interests are safeguarded, and employers are protected to a considerable extent against unfair competition.

In 1918 an Act of Parliament was passed making provisions for the appointment of wages boards with power to fix wages for women and young persons in certain occupations with the object of preventing sweating. The 1918 Act was repealed by the Wages Act of 1925, in which provisions are made for the appointment of a permanent wages board having power to deal with the wages of all classes of workers employed in any industry other than those employees whose conditions are governed by agreements under the Industrial Conciliation Act of 1924.

CHAPTER V.

A REVIEW OF INDUSTRIAL CONDITIONS.

IT is convenient to group industries in four centres, viz., Cape Western Province, Port Elizabeth, Durban, and the Witwatersrand.

Cape Western Province.

This, the oldest Province of the Union, possesses the important seaport of Capetown, where, generally speaking, industries of all kinds are carried on. The population of Capetown, Municipality comprised in 1926 113.027 Europeans and 101,336 non-Europeans, and including Wynberg 124,422 Europeans and 114,245 non-Europeans, affords a good labour market apart from the reservoir of native labour available inland. The Province is well served by railways, is in direct communication with all other Provinces of the Union in this respect, and being situated at the southern extremity of the Peninsula is well placed for export trade, particularly as the port of Capetown is on the direct ocean route of steamers going to the East.

Port Elizabeth.

This is the largest town in the Eastern Province, and on account of the large number of boot and shoe factories is frequently spoken of as the "Northampton" of South Africa. Other important towns in the Eastern Province are Kingwilliamstown, East London, Queenstown Mossel Bay, Aliwal North, and Oudtshoorn. Notwithstanding the number of industries that flourish in this district, there would appear to be ample room for more. For example, there are considerable deposits of fine white clay, fruit is grown in plenty, and the plants necessary in the manufacture of brooms grow in the district in great profusion. Fibre plants are also grown in large quantities; there are several varieties, and the extraction of fibre should prove an industry worthy of fostering. Wool is produced in abundance, red ochre is found in all parts, tobacco of all grades is grown, and wattle and wattle bark are plentiful. Port Elizabeth is well situated for both inland and oversea trade; it is connected by rail with all inland railway systems, and the outputs of the various factories find a market throughout the Union of South Africa and Rhodesia.

Durban.

This is the largest town in the Province of Natal, and is rapidly forging ahead industrially. Many large important industrial concerns are established in the town, and others are in process of construction. The growing of sugar-cane on the coast belt of Natal keeps a large number of sugar refineries in operation, and there are considerable quantities of by-products produced. The development of the port is proceeding apace, and upon much of the land reclaimed, factories are being built. The town is excellently placed in the matter of rail and sea communication; it is the nearest port to Johannesburg and to the centre of the gold and coal fields, and all classes of shipping are able to come right into the docks. Labour is plentiful and reasonably cheap; the unskilled workers are drawn from the Zululand reservoir near by, and, in addition, there is an ample supply of Indian labour.

Witwatersrand.

This is a plateau 6,000 feet above sea-level, where the gold reef is found. The area extends approximately 60 miles east and west, and supports a dense population. Johannesburg, the chief town, possessed a population of 282,971 in 1921, made up of 150,286 Europeans, 115,120 natives, and 17,565 Euro-Africans and Asiatics, and a European population of 168,545 in 1926. In addition to Johannesburg, there are many towns of smaller size all connected by rail to the former, the train service being frequent, regular, and comparatively fast. Industries of all kinds have sprung up to meet the requirements of a large population, and, of course, there are vast tracts of country inhabited by Europeans and natives to be served up-country and inland generally. The town of Pretoria (the capital) is included in the Witwatersrand for the purpose of this review; it is connected direct to Johannesburg by rail, and a fast and frequent service of trains is daily in operation. The distance by rail is 45 miles; by road it is 10 miles less.

It will be understood that the mining industry employs a huge army of workers (20,782 Europeans and 183,965 coloured persons, preliminary figures), and, naturally, factories have been established to supply the demands of employer and employee.

The chief class of industry on the Witwatersrand is that connected with engineering (including cement works), but, generally speaking, there are factories and workshops dealing with every kind of product. For instance, the last industrial census disclosed that the Witwatersrand possessed 175 establishments for the manufacture of vehicles, whereas the next largest centre was Capetown with 97. Similarly, food and drink factories on the Witwatersrand totalled 289, Durban 74, Port Elizabeth 41, and Cape Peninsula 255.

The growing of what is termed "Transvaal tobacco" has resulted in the erection of many large factories, at which large numbers of workers are employed. Recently many farms have been planted with cotton, and it would appear that this industry has enormous possibilities. Cotton "gins" have been erected in various parts of the district, and a fairly large export trade with Europe is now in operation.

The Witwatersrand may also be stated to be the centre of maize cultivation, and a large factory for the making of starch and other maize products is operating successfully.

Municipal Industrial Facilities.

Without exception, all local authorities welcome the establishment of industrial concerns, and many of them have special committees dealing expressly with the subject of encouragement of industries, etc. All the larger municipalities have their own power stations and water supplies; and, in many, special cheap rates are in operation for factories and other industries.

(1) *Capetown.*

Electric energy is supplied under special contract at bulk supply rates. Ample land is available for the erection of factories, and as far as health and sanitation are concerned, the city stands in a similar position to the large towns of Great Britain. Water is supplied for industrial purposes at 2s. 10d. per 1,000 gallons at from 100 ft. to 250 ft. head pressure.

In the Cape Province there are many other towns, such as Wellington, Stellenbosch, Robertson, etc., possessing factories of all kinds, and in order to encourage industries the various local authorities have established schemes, such as—

(*a*) areas of ground set aside for industrial purposes;
(*b*) railway sidings available, if required;
(*c*) special cheap water and light rates;
(*d*) special cheap electric power rates.

(2) *Durban.*

Sites are available for industrial purposes, and Government leases may be secured on favourable terms. All necessary information may be obtained from the town clerk.

In the smaller towns of Natal special facilities exist, such as suitable areas of land at £5 per acre at Ladysmith, cheap water and power rates, and so forth.

(3) *Port Elizabeth.*

Land has been specially set aside for industrial purposes, and the Council is prepared to assist applicants for sites. There is a particularly good water supply, and the rate for industrial purposes is 1s. 6d. per 1,000 gallons for the first 100,000 gallons, decreasing 1d. per 1,000 gallons for every 100,000 gallons used after the first 100,000. Electric power is supplied by the municipality at a low cost.

In other towns of the Eastern Province various facilities exist; for example:—

East London.—Several sites owned by the Council eminently suitable for factories, can be purchased at low rates. The sites are conveniently situated and near to the main line of the South African Railways and to the Buffalo Harbour. Arrangements can be made with the railway authorities for the necessary railway sidings.

Kingwilliamstown.—Most suitable factory sites have been set aside by the Borough Council which can be purchased at a low figure and on very easy terms, or they may be leased at exceedingly moderate rentals. Other facilities consist of abundant water (soft), plentiful cheap labour supply, and cheap rates for electric power and water.

Uitenhage.—Twenty-one miles from Port Elizabeth. The town possesses a large commonage providing suitable sites for factories, and the Council is prepared to deal generously with applicants. Electric power, electric light, and the water supply are abundant and cheap. There are large railway workshops here covering 100 acres and employing a large number of workers.

(4) *Witwatersrand.*

Johannesburg.—The Council owns its own power station and gives every assistance to firms desirous of establishing industries. At present the Council is considering the acquisition of further ground for industrial purposes, as the original sites owned by the Council have all been disposed of. The large municipal market has an annual turnover between one and one and a half million pounds, most of the produce arriving by rail. This will give some indication of the town's domestic business. The population is larger than that of any other town in the Union, and consequently offers a market for all kinds of produce. The water supply is ample and pure, and the Council possesses adequate storage capacity. Assessment rates are levied at present on the capital value of land only and amount to 7d. in the £1 for the year ended 30th June, 1926.

Germiston.—Nine miles from Johannesburg by rail. The electric power station of the Victoria Falls and Transvaal Power Company, Ltd., is situated on the Victoria Lake at Germiston, and is contiguous to the industrial sites. There is a sub-station on the industrial area itself for the distribution of electric power for manufacturing purposes.

Special industrial sites have been laid out by the Council with rail communication direct to the site, and the price is £336 per acre freehold, including the rail siding, which is a frontage to the stand. Rating is upon the land only, and at 7d. in the £1 (for the year) is £9. 16s. for an acre of ground valued at £336.

Germiston is an important railway centre; it contains the Gold Refinery, and is in the centre of a large industrial area.

General.

It is impossible to deal with every town in this volume, but an attempt has been made to give some idea of the industrial conditions of the country. It can be said, without qualification, that all municipal councils are anxious to encourage industries, and while some of the larger have special schemes and special sub-committees dealing with this subject, yet all, without exception, offer special terms and conditions in the way of cheap sites, cheap power, light, and water to industrial establishments. Particulars in detail can be obtained from the town clerks of all the local authorities.

Industrial Legislation.

With the growth of industrialism, it followed that public opinion would demand legislation to protect the country from many of the ills and abuses which have retarded older industrial countries, and the following are among the laws that have been promulgated:—

Factories Act, No. 28 of 1918.
The Regulation of Wages, Apprentices, and Improvers Act, No. 29 of 1918.
Juveniles Act, No. 33 of 1921.
Apprenticeship Act, No. 26 of 1922.

CHAPTER VI.

ASSIZING OF WEIGHTS AND MEASURES.*

THE Weights and Measures Act came into force on the 2nd April, 1923, and the Regulations on the 1st May, 1923. The Act has been in operation for over two years, and it is now possible to review its operation and form some idea as to the suitability of the measure for this country.

It has from time immemorial been a universally recognized axiom that trade can only be conducted on the basis of some accepted standard, whether, as in the case of primitive man, that standard be a pebble or the span of the human hand, or, as in modern practice, a quantity defined with the greatest scientific accuracy and possessing qualities which reduce to a minimum its liability to variation. In the Union Act, the fundamental units of the Metric System, the kilogram and the metre are adopted as the reference units of weight and length, from which all other standards are derived. This enables the units of the standard weights and measures actually in use to be defined in terms of the standards deposited at the International Bureau of Weights and Measures to within one part in ten million. The wisdom of this arrangement may yet be seen if and when the Union adopts the metric system, or in the event of other parts of South Africa in which the metric system is used being linked up with the Union.

The passing of the Act swept away several anomalies in so far as recognized standards are concerned. In Natal the ton was 2,240 lb., whereas in the Transvaal and the Orange Free State it was 2,000 lb., with the optional use of either quantity in the Cape. Similarly, there were the imperial gallon, the American gallon, and the "old measure gallon," which were recognized commercially throughout the various Provinces, and all of which differed as to the quantity they were supposed to represent. The system of weights and measures in use in the Union is the Imperial System with the Metric System as permissive under certain defined conditions.

Prior to the coming into force of the Weights and Measures Act, the assizing of weights and measures was carried out on modern lines by the Municipalities of Johannesburg, Durban, and Pretoria, and it was only after many years of agitation on the part of the commercial community that the Government ultimately decided to make the regulation of weights and measures a national matter. The Union Act is recognized as being one of the foremost pieces of legislation on the subject of weights and measures, and it is probable that had it seen the light of day at an earlier date it would have emerged from Parliament in a much less satisfactory form. Since the commencement of the Great European War several countries have had to adopt emergency measures for the better protection of the public, and there are numerous traces of the experience so gained in the working of those measures to be found in the various provisions of the Union Weights and Measures Act.

* By J. C. Davidson, Superintendent of Assize.

It may here be mentioned that the Government of Southern Rhodesia has recently adopted practically every provision of the Union Act.

The main provisions of the Act may be summarized thus:—The use of uniform weights and measures throughout the Union; the prohibition of instruments having novel features for trade use, unless and until approved by the Assize Board; false, unjust, and unassized weighing and measuring appliances are prohibited; goods sold by weight must be sold by net weight; certain specified commodities, when made up in packages or tins, must be put up in accordance with a prescribed scale of quantities; and finally, goods which are imported may be held up at ports of entry by the Customs Authorities, unless they are in accordance with the provisions of the Act and Regulations.

It is a truism, however, that the best of Acts, unless properly administered, has a tendency to become a dead letter, and this applies with peculiar force to a Weights and Measures Act.

Turning then to the question of administration, the Government had two alternatives, either to undertake the whole or delegate a part to the larger municipalities. It chose the former after mature consideration of the question in its various aspects and bearings. The first duty was to get together the nucleus of a working staff. At first thought this might not appear to be a very difficult matter, but to any one possessing something more than a superficial acquaintance with the subject, it will not be a matter of surprise that this task presented considerable difficulty. Fortunately, there were in the country several men of experience who had previously served under one or other of the municipalities that had established an Assize Department to meet the needs of their particular areas, and from these it was found possible to select sufficient suitable men to take charge of the six districts into which the Union was divided for the purpose of administration. For the rest, assistants were recruited from applicants who, though they had no practical training, appeared to have the necessary educational qualifications likely to enable them to successfully pass the examination prescribed in the Act.

Attention was first given to the larger towns, and from those the activities of the Department have radiated outwards to the rural areas, until to-day almost the whole of the Union has been visited by an assize officer. Apart from the use which was made of the railways, the Department had at the outset a modest fleet of three Ford cars. As experience of transporting large quantities of assizing equipment was gained, it soon became evident that motor transport would have to a large extent to take the place of railway transport if all the villages in the rural districts were to be visited. These are often to be found at distances of 100 miles and upwards from any railway line. It also became apparent in the early stages of the work that a much more powerful vehicle than a Ford car would be required if the work were to be successfully carried out, and during the past twelve months the transport service has been augmented by the supply of five Dodge screen vans, which are proving an efficient, and, on the whole, an economical and rapid means of transporting officers and their equipment to the various assizing centres. The itineraries which are arranged for rural areas are planned so as to enable the officers, as far as possible, to carry out their work in the dry season, but even so, almost impassable roads are a common experience, and the lot of the assizer is frequently a very unenviable one.

Not the least important part of an assizer's equipment is a plentiful endowment of tact. Especially is this necessary when dealing with traders

in country districts who, for the first time it may be, are having an official test applied to their weighing and measuring instruments. Unlike the urban trader, these people have not learned to appreciate the value of accurate and sensitive appliances. To many of them a scale which slowly oscillates between two fixed points must be a perfect weighing machine, and the question of leverage or lack of sensitiveness never appears to appeal to them. It is by no means unusual to find a platform scale, when loaded with, say, 1,000 lb., so lacking in sensitiveness through many years of wear, that it may require as much as 10 lb. to be added in order to cause the instrument to record 1,000 lb. Presumably a farmer who had his wool weighed on such a scale would readily appreciate the point if he were being paid 2s. per lb. for his wool.

Then again, when a scale has to be rejected as unfit to comply with the Government regulations to which the assizer must work, the question of having the necessary repairs effected is one which gives a considerable amount of trouble to the officials. The fact that scale-repairing is a highly-specialized trade and cannot, as a rule, be undertaken by an ordinary blacksmith or engineer, results in this class of work being confined to a comparative handful of firms who are competent to undertake it. Some of these firms, who are more enterprising than others, arrange to follow up or even precede the published itineraries of the assizer. The simultaneous appearance of their representatives and the assizer, in any area, often leads the trader to conclude that the Government official is nothing more or less than an agent for the repairing firm. The very suggestion of this is a constant source of worry and annoyance to the assizer and to the Department. On the other hand, it as frequently happens that the assizer goes to a sparsely populated district and is not followed up by a repairer. In such cases the complaint is made that there is no one who can undertake the repair work. The Department endeavours to deal with such cases with the greatest sympathy, and certainly has not been guilty of harassing traders who find genuine difficulty in complying with the law in so far as their appliances are concerned. Those difficulties will gradually disappear, and it is confidently anticipated that in the course of the next few years the operations of the Department will be carried out with a minimum of friction.

New Types of Apparatus.

It may be of interest to state that the Assize Board has been kept unexpectedly busy during the last two years with applications to introduce, for trade use, different kinds of weighing and measuring apparatus possessing novel features. In all, during that period, over forty new types have been dealt with, and in several instances certain modifications designed for the better protection of the public were insisted on, whilst in one instance the instrument was refused owing to defects in the principle on which it was constructed. In the above connexion it is remarkable how the old types of weighing and measuring instruments are being replaced with automatic or visible recorders, which rapidly perform the work required of them with wonderful accuracy. The supervision which is thus exercised by the Board safeguards the unsuspecting trader against the blandishments of any adventurer who might attempt to sell him an instrument which he would later discover he was not allowed to use in trade.

Some idea of the magnitude of the work and activities of the Assize Department may be gathered from the following facts:—During the year ended 31st March last, the assize

officers examined 36,544 weighing instruments, 157,801 weights, and 144,969 measures, and collected in fees the sum of £14,975.

The condition in which the appliances were found when examined is reflected by the fact that of the weighing instruments, 8,054. or 22 per cent., were either rejected for defects or as being unfit for further trade use. In the town areas, the percentage of defective instruments would be considerably less. This is due to the fact that attention was first devoted to the appliances used by traders in the large towns.

The inspectors of weights and measures—three in number—whose duty it is to see that weighing and measuring appliances are duly assized and not put to improper use and that the regulations pertaining to the sale of bread, butter, butcher-meat, coal, firewood, and many other commodities largely used by the public are being properly observed, made 10,457 visits in the course of the year. A large number of check-weighings of various kinds of goods was made during the year, and where the deficiencies were of a serious nature the delinquents were prosecuted.

The total number of prosecutions for the year was 314, of which 88 were for unassized or unjust scales and weights, 49 for short-weight bread, 13 for short-weight coal, whilst 64 were for miscellaneous offences not enumerated above. The total fines inflicted amounted to £821. 5s. The highest fine imposed in any one case was £25. This occurred on two occasions.

In some parts of the country the police are able to render very substantial assistance. Especially is this the case in connexion with the dissemination of information regarding the fixed itineraries of assizers to the different areas, and the visiting of country stores to see if rejected appliances have been attended to. They have also taken proceedings for minor offences against a considerable number of traders in various parts of the Union—the figures are not at present available.

The authorized staff of the Assize Department is as under:—

1 Superintendent.
1 Chief Clerk.
1 First Grade Clerk.
1 Third Grade Clerk.
1 Typiste.
7 District Assizers.
6 First Grade Assizers.
8 Second Grade Assizers.
1 Senior Inspector.
2 Inspectors.
6 Junior Assistants.

Making in all a total of 35. When it is pointed out that the City of Glasgow, with a population of a million people and its work concentrated in a comparatively small area, requires a larger staff than has so far been sanctioned for the whole Union, it may be realized that whatever defects the Assize Department may have it cannot very well be argued that it is overstaffed.

Benefits of Uniformity.

The benefits which have accrued to the community as a whole through the introduction of a uniform measure for the whole of the Union are perhaps most appreciated by merchants who do a considerable inter-provincal trade. Formerly, it was a matter of almost every-day occurrence for a trader, say, in Johannesburg to purchase a truck of fodder in the Cape Province and find on its arrival at Johannesburg that there was a huge discrepancy—cases are on record where there was a deficiency of as much as 2 tons on an 11-ton truck—between the weight for which he was called upon to pay and the weight which he actually received when the goods arrived. In such cases there was no legal remedy as the seller invariably took the precaution to stipulate that seller's weights would be final. This

one-sided method of conducting business is happily no longer possible.

Then again, now that standard weights have been fixed throughout the Union for most of the agricultural commodities which are sold by bag, competition as between merchants in the various Provinces has been reduced to a uniform basis. Previously, although there was a general recognition of defined weights for bagged goods in the trade, the standard so recognized had no legal force and it was open to a miller, for instance, to quote a price per bag for mealie meal and then vary the standard quantity to suit his own fancy. But the benefits are by no means confined to the trader dealing in large quantities of goods. They are equally apparent in the case of the householder buying the ordinary necessities of food. The standardized loaf has superseded the nominal weight loaf, and similarly with such commodities as jam, for example, which was often met with in weights of 13½ ounces per tin instead of the full pound.

Finally, the appliances used by traders are kept under surveillance, and shop weights—particularly is this true of rural districts—which had decreased in weight through constant wear by as much as an ounce per pound, are now maintained at the true standard weight.

It may here be of interest to state that the Union Standards are copies of the standards in the custody of the Warden of Standards at Palace Yard, Westminster. The former have been copied by the British Board of Trade to a high degree of accuracy, and are only used for calibration of the Departmental Standards, which in turn are used for the verification of the Local Standards used in the District Assize Offices. There is thus an unbroken chain connecting the standards used in the verification of trade weights and measures with the imperial units of weight and measure.

CHAPTER VII.

THE POWER SUPPLY INDUSTRY.*

THE development of the electric power supply industry in South Africa is marked by two distinct steps. The first was taken some seventeen years ago, when the Victoria Falls and Transvaal Power Company and the Rand Mines Power Supply Company established their system to supply power to the gold mines of the Witwatersrand. This system exemplifies in a large measure what most countries are to-day striving for, namely, the supply of power over a large area from a few interconnected stations, and is perhaps still one of the largest of its kind in the world.

The second step was taken recently with the introduction of legislation to guide and control future developments in power supply and the decision of the Government to embark upon an extensive policy of railway electrification.

The rest of the power supply industry in South Africa does not stand out as having been of more than normal influence in fostering the industrial development of the country. It is true that almost every small town in the Union enjoys the use of electricity, generated usually in small plants in each town or village, but electricity is not used for production purposes as widely as it might be; nor has it been possible in the past to obtain it at a sufficiently low cost to act as an inducement to industries requiring relatively large amounts of power, such as electro-chemical industries. It is hoped, however, that the developments contemplated at present will make it possible to put to more effective use the facilities which the country offers for the establishment of such industries.

That electricity is seldom produced in the most economical manner is recognized the world over. It is for this reason that in so many countries strenuous efforts are being made to transform the systems of power supply by eliminating the smaller and less efficient stations and supplying power from large stations. The advantages of such regional systems are numerous, the more important of which are—

(1) the capital cost per kilowatt of a power station decreases as the size of the station increases;
(2) the efficiency increases with the size of the units;
(3) administration and working costs decrease as the size of the station increases;
(4) the larger the number of consumers the greater becomes the diversity of demand, and consequently the higher the load factor on which the station can operate;
(5) the interconnection of such stations ensures better continuity of supply and further helps to build up a higher load factor.

To bring the regional system of power supply into practice, however, is difficult. Where it is perhaps most needed is in districts that have reached a high state of industrial development. But under conditions pertaining to a high state of industrial development there usually already exists a comparatively large number of power

* By H. J. van der Bijl, M.A., Ph.D., M.Am.I.E.E., M.I.R.E.E., etc., Chairman, Electricity Supply Commission.

stations, more or less efficient, which spring up as the need for electric power grows.

The elimination of the smaller and less efficient stations is usually not simple, and often means a lengthy and difficult period of transition.

South Africa is still in a position to develop its systems of power supply along the right lines, since the country has only a few developed industrial areas of importance. These areas have been developed much in the same way as in other countries, and naturally fairly difficult problems would be encountered in an attempt to direct the future development of power supply in these areas along lines that are now recognized as correct. But the difficulties in the way, as compared with more highly developed countries, can be considered as relatively small.

As regards districts that possess industrial potentialities but are as yet undeveloped, the question of establishing systems of power supply becomes relatively easy whenever it is feasible to electrify the railways, provided that the power stations established for supplying the railway traction load can also supply power for other purposes. The amount of power required for railway traction purposes is usually sufficiently large to form the initial demand necessary for establishing a regional system.

Development along such lines means that the railways in the initial stages must bear the burden of small diversity, but they derive the economic advantages of electrification and of a future increase in traffic from industrial activities that can be expected to grow as a result of the availability of relatively cheap power in that area. Where power is made available through railway electrification, the industrial potentialities of a district are considerably enhanced thereby, because it means not only cheaper power, but also better transportation facilities. Considering the conditions prevailing in South Africa, I believe that the establishment of power supply systems in the Union by electrifying the railways will have a pronounced effect in fostering the industrial development of the country.

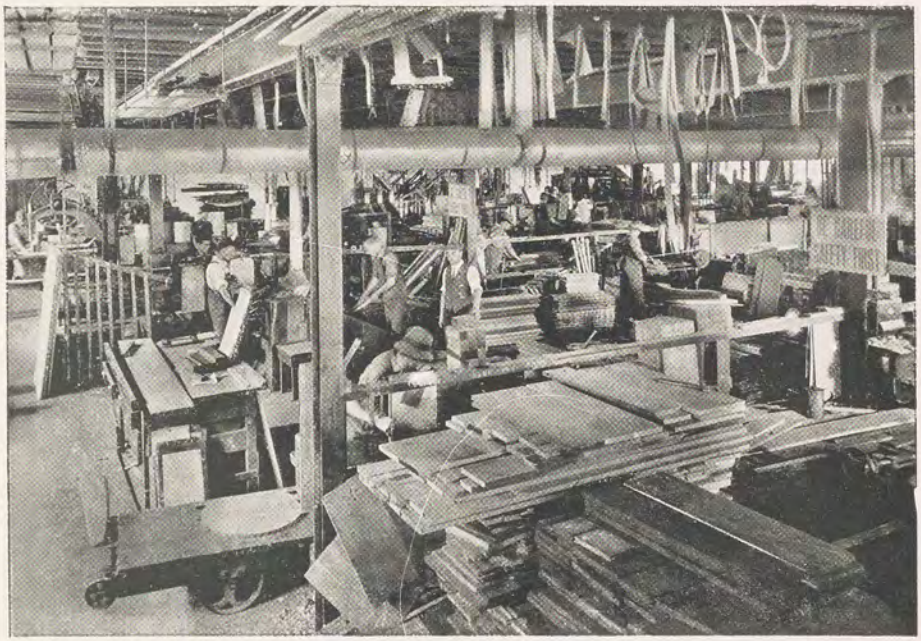
The Electricity Act, 1922.

To build up a power supply industry along the right lines and prevent haphazard growth requires guidance and control to a more than ordinary extent. This is all the more necessary because the supply of power is a public utility of great importance. Legislation has recently been brought into force in South Africa which should provide for very effective control and guidance, and which will, it is hoped, ensure in large measure that future developments of the power industry will be in the best interests of the public. This legislation is embodied in the Electricity Act, No. 42 of 1922.

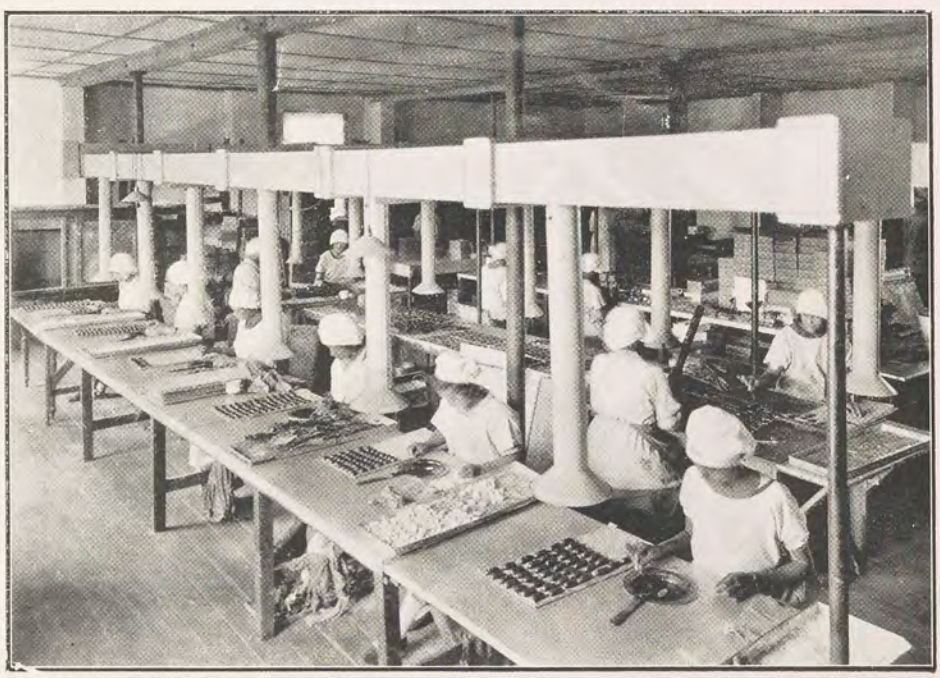
This Act is based, firstly, on the recognition that the power supply industry is a very important public utility. This, however, does not mean that this industry should be undertaken by the State. It was felt rather that the door should remain open to private enterprise, but that the industry should be under Government control to a reasonable extent. Such control is especially necessary in view of the fact that to allow free competition in power supply leads to duplication of distribution systems, and helps, rather than avoids, the establishment of small and less efficient power stations. In other words, the most economic means of supplying power requires giving a virtual monopoly to a power supply undertaken in any one area. At the same time it was felt that the industry could materially benefit by combining the advantages of both Government and private enterprise.

The Electricity Control Board.

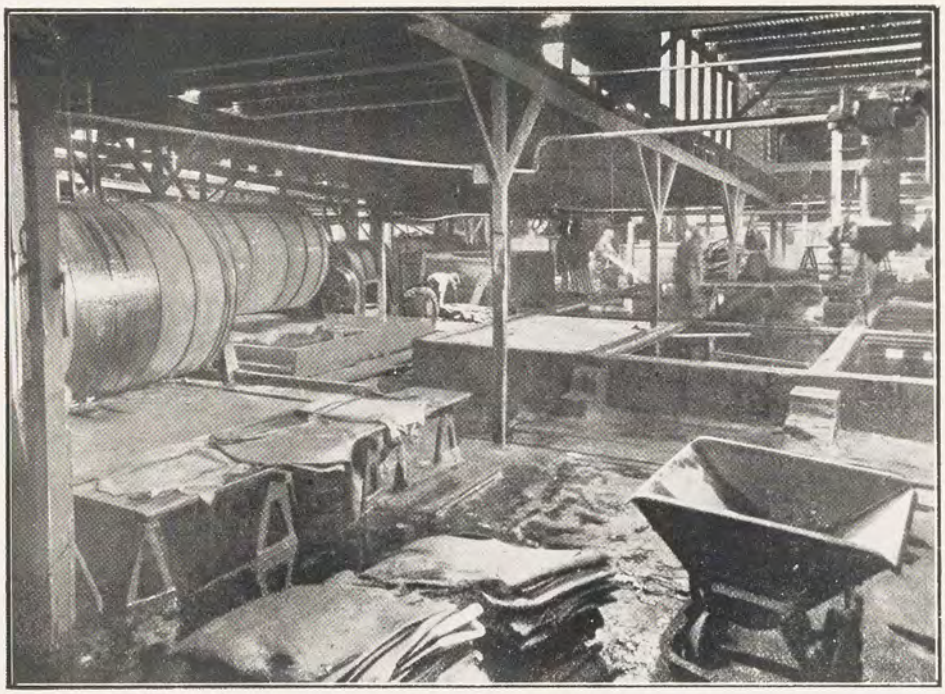
The Act provides, therefore, for the establishment of a body, the Electricity Control Board, which is a Government board, and to which



Furniture Factory : Bell, Webb & Bell, Ltd., Observatory, Cape.

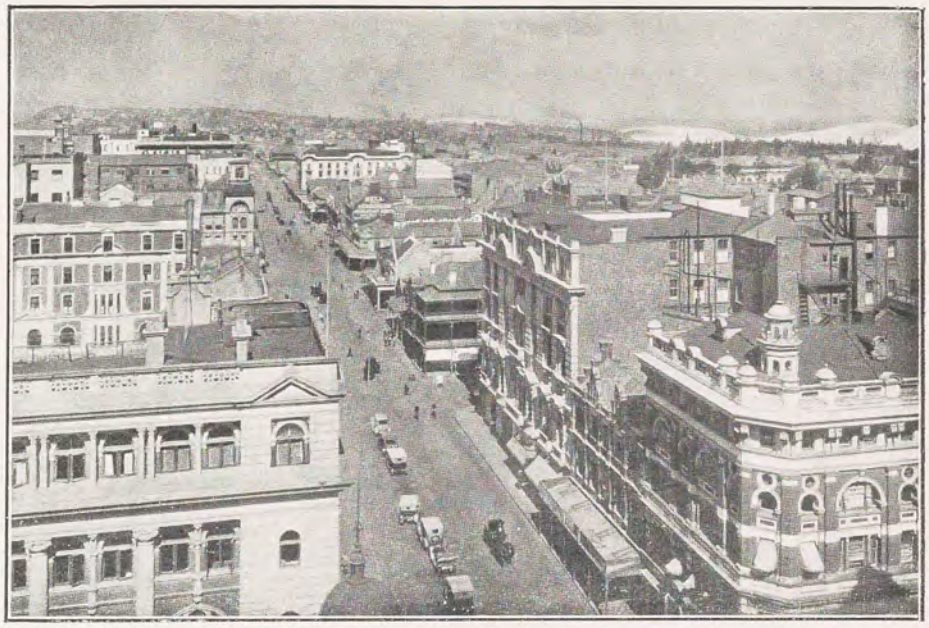


Woodstock Sweets Co., Ltd., Capetown.



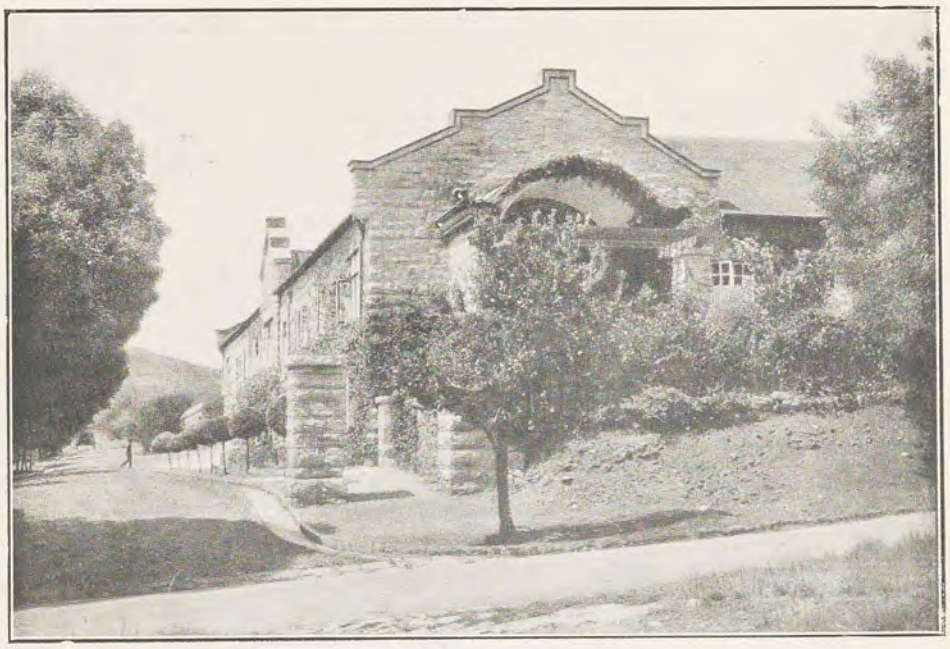
SECTION OF NO. 2 TANYARD: MOSSOP & SON, LTD., RONDEBOSCH, CAPE.

SECTION OF CURRIERS' FLOOR: MOSSOP & CO., LTD., RONDEBOSCH.



JOHANNESBURG FROM TOP OF CORNER HOUSE.

MARKET SQUARE, JOHANNESBURG.



WHERE CINEMATOGRAPH FILMS ARE MADE.
Killarney, Johannesburg.

THE MODERN METHOD OF PARCEL DISTRIBUTION.
Portion of the Railway Administration's Fleet of Motor-lorries at Johannesburg.

applications must be made for licences for the establishment of electricity undertakings.

The Control Board has extensive powers in the granting or refusal of such licences, but every application for a licence is carefully considered, and provision is made in the Act for a public hearing in case any interested party should lodge an objection to the granting of the licence. The Control Board was established in September, 1922, under the chairmanship of Sir Robert Kotzé, who is responsible in a large measure for the fundamental ideas underlying the Electricity Act.

The Electricity Supply Commission.

In order to obtain the advantages of both Government and private enterprise in the generation and supply of power and to direct the development of the industry as far as possible to meet the public interest, provision is made in the Act for the establishment of another body, the Electricity Supply Commission, which, in its functions and powers and its position relative to the Government on the one hand and private enterprise on the other, is different from anything existing anywhere, although it is in some respects similar to the Hydro-electric Power Commission of Ontario and the Victoria Electricity Commission in Australia.

The Electricity Supply Commission is a body corporate, capable in law of suing and being sued, and of doing and performing all such acts and things as corporate bodies may by law do and perform.

The functions and duties of the Commission, briefly stated, are the establishment, maintenance, and working of undertakings for the supply of electricity to the Government and any other bodies or persons whatsoever in the Union of South Africa, and the investigation of new or additional facilities for the supply of electricity and for the co-ordination and co-operation of existing undertakings so as to stimulate the provision of a cheap and abundant supply of electricity.

For the purpose of carrying out this work the Commission has the following powers:—

(*a*) To appoint and employ such technical officers, engineers, secretaries, accountants, clerks, workmen, and other servants as it may deem requisite, and to dismiss them.

(*b*) To pay any person in its employ such salary, wages, or other remuneration as it may deem fit.

(*c*) To raise money by way of loan, subject to the provisions of this Act.

(*d*) To acquire by purchase, lease, or otherwise, land, or rights, or interest in or over land, water-rights, rights to coal, and to property of any description whatsoever, and to work or otherwise beneficially use any property or rights so acquired.

(*e*) To acquire by purchase, lease, or otherwise, or to construct, and to maintain, alter, or improve buildings, machinery, plant, transmission and distribution lines, waterworks, reservoirs, railways, roads, bridges, water-courses, pipe-lines, and any other apparatus or works.

(*f*) To exchange, let, sell, or hypothecate any of the property or plant acquired or constructed under paragraphs (*d*) and (*e*).

(*g*) To cause surveys, plans, sections, maps, drawings, and estimates to be made by or through its officers, servants, or agents.

(*h*) To cause entry to be made by or through its officers, servants, or agents upon any land for making plans and surveys thereof: Provided at least seven days' notice to the owners of such land shall be given and compensation shall be paid for any damage done by its officers or servants.

(*i*) To enter into contracts, not inconsistent with any provision of

this Act, with the Government, the South African Railways and Harbours Administration, urban or other local authorities, companies, and other persons for the supply of electricity.

(*j*) To make and recover charges for electricity supplied, but subject to the provisions herein after contained as to prices.

(*k*) To purchase or sell coal or other fuel, steam, water, and other materials and stores.

(*l*) To manufacture and sell by-products.

(*m*) To insure with any company or person against any losses, damages, risks, and liabilities which the Commission may incur.

(*n*) To purchase or otherwise acquire electricity from any other undertaker or person.

(*o*) To enter into any contracts with any person or body of persons.

(*p*) To promote or oppose private Bills in Parliament.

(*q*) To contribute to or grant pensions or gratuities to persons in its employ or to the dependents of the deceased employees.

The Act provides that the Commission shall consist of not less than three and not more than five members appointed by the Governor-General, and can be removed from office by the Governor-General on the grounds of incapacity or misbehaviour. This is the extent to which the Government controls the Commission itself. As regards the work of the Commission, the Government exercises control to the extent that before the Commission can raise money by way of loan for any of its undertakings it must obtain the sanction of the Governor-General.

The Commission is further controlled in the same way as any private electricity undertaker, namely, that before establishing an undertaking it must apply to the Electricity Control Board for a licence to do so, and the procedure followed by the Board in regard to the investigation and public hearing of the application is exactly the same as in the case of an application of any private corporation or person.

An important advantage is that the Commission can, during the first four years of its existence, borrow from the Government, by way of loan, moneys necessary for financing its works. The moneys so advanced and the interest thereon become a liability of the Commission and are charged on its assets and revenues. This facility, which enables the Commission to finance itself through its babyhood at a low rate of interest, is strongly conducive to the provision of cheap power supply.

Another difference between the Commission and private enterprise is that the Commission must, as far as practicable, operate on the basis of neither profit nor loss. This would at first sight appear to militate against the plan contemplated in the Electricity Act, but the powers of the Commission are otherwise so wide that this difference is more apparent than real. For example, the employees of the Commission are not civil servants, but are appointed and promoted by the Commission in exactly the same way as in an efficient private corporation, and the conditions attaching to the posts of the Commissioners are such as to make any possible political interference impossible. Employees do not work for dividends but for promotion, and as long as merit leads to promotion, efficiency of service can be expected. As far as the Commissioners themselves are concerned, success or failure is closely linked with their reputation, and they furthermore have a responsibility towards the bondholders of the Commission which is at least equally important and severe as the responsibility of the directors to the shareholders of their company.

It is seen, therefore, that the Electricity Act makes a genuine attempt at combining the advantages of both

Government and private ownership and operation in matters of power supply. The Electricity Supply Commission may be regarded as being in the nature of a public utility corporation with Government backing. The underlying principles of the plan appear to be sound, but considering that it is a departure from the ordinary, the plan could hardly be expected to be perfect in detail. Where improvement may be necessary, this could only be effected as the result of experience. The Commission was appointed in March, 1923, with the writer as chairman and whole-time member, and Messrs. R. Niven and J. R. Fulton as part-time members.

SOME OF THE MORE IMPORTANT POWER SUPPLY SYSTEMS.

(a) The Rand-Witbank Area.

By far the most important power supply system in South Africa is that of the Victoria Falls and Transvaal Power Company and the Rand Mines Power Supply Company. The system originated in 1906 with the idea of developing the water-power of the Victoria Falls in Rhodesia for supplying power to the gold mines on the Rand. This meant transmission over a distance of about 700 miles, and the plan was consequently modified. All the power supplied from this system is generated in coal-fired stations.

Two small power supply companies had been established before the advent of the Victoria Falls and Transvaal Power Company, and the establishment of another was being contemplated by Lewis & Marks, who had obtained wayleaves for a power line from Vereeniging to the Rand, the object being to establish a power station on the Vaal River and on the Vereeniging coalfields. These two companies and the Lewis & Marks' rights were taken over by the Victoria Falls and Transvaal Power Co. Thus were taken the first steps in the establishment of a regional system on the Rand. The Rand Mines Power Supply Co. is a subsidiary of the Victoria Falls and Transvaal Power Co., the capital being provided by the latter, but the former being registered in the Transvaal.

The power supplied by these two companies (the "V.F.P." system), is generated at four stations. A significant feature of the system is that it supplies not only electrical energy but also compressed air from three central stations through a system of underground pipes. Some of the air is supplied from steam turbo-compressors at two of the power stations, the other portion being supplied from the Robinson Central compressor station, where the compressors are driven electrically. The total capacity of the compressors is 79,000 horse-power. This includes three turbo-compressors of 10,000 horse-power each.

The total system, electricity and air, is capable of developing something like 350,000 horse-power, and the energy sold is close to a thousand million units per annum.

The capacity of the stations is as follows:—

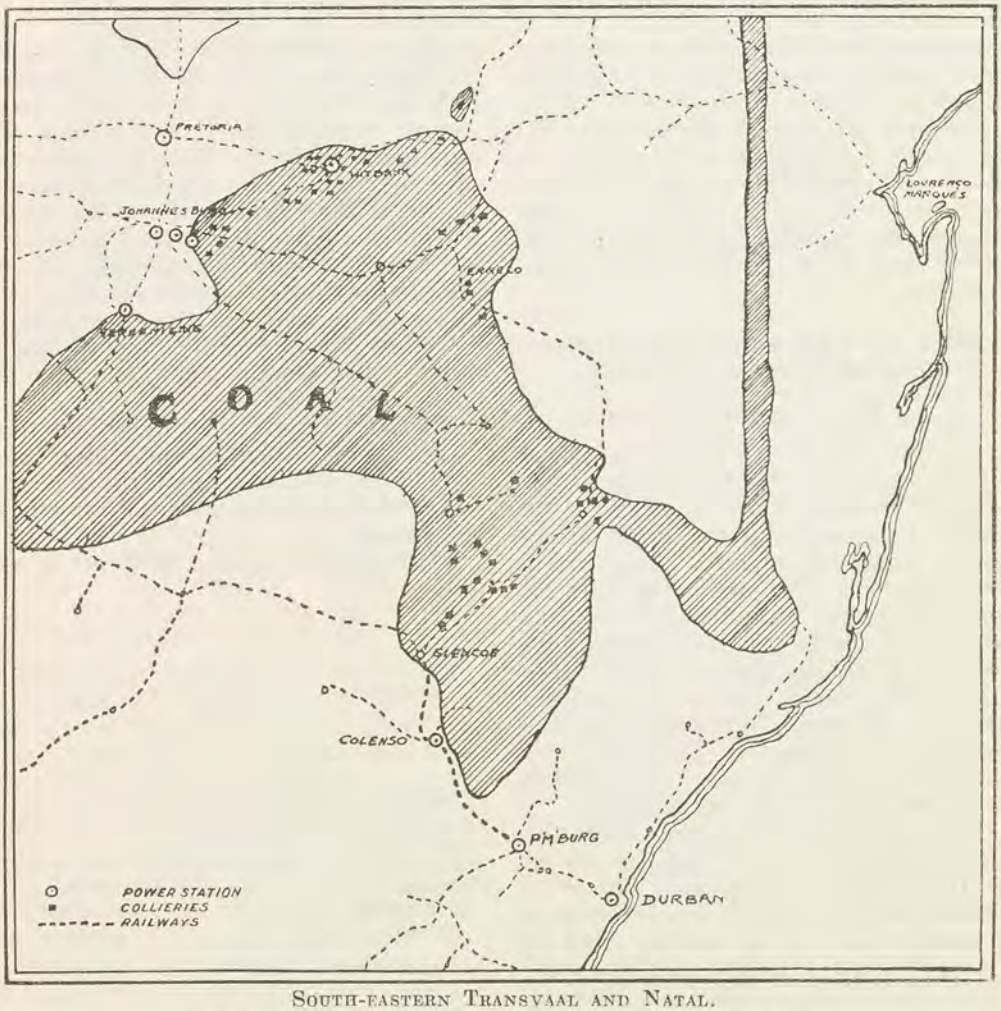
Station.	Electric Generators (Total).	Compressors (Total).
Rosherville.....	60,000 k.v.a.	50,000 h.p.
Vereen'ging.....	60,000 k.v.a.	—
Simmer Pan....	54,000 k.v.a.	—
Brakpan.....	44,000 k.v.a.	9,000 h.p.
Rob'nson..... (Compressor station)	—	20,000 h.p. (electrically driven)

The distribution system comprises partly overhead lines at voltages ranging from 80,000 volts down and partly 20,000-volt cables. The overhead lines total 389 miles and the cables about 50 miles.

There are 95 consumers' sub-stations with a total transformer capacity of about 400,000 k.v.a.

The fact that the whole of this system is at an altitude of about 5,600 feet above sea-level, in a portion of the country which is subject to severe thunderstorms during the early summer months and to high winds towards the end of winter, makes it very interesting from an engineering point of view.

The area of supply is a narrow strip about 40 miles long by 3 miles wide. The only station not within the area is Vereeniging, which is on the Vaal River, about 35 miles to the south, and feeds into the system over an 80,000-volt line.



SOUTH-EASTERN TRANSVAAL AND NATAL.
Showing Area where Coal is known or believed to exist.

Power is supplied mainly to the gold mines on a sliding scale of prices, the present price being 0.525d. per unit for a load factor of 70 per cent. and over. The companies also furnish power to some of the municipalities on the

Rand and to industries outside the municipal area of Johannesburg itself, which generates its own power.

Germiston is an example of a town of moderate size supplied from the V.F.P. system. The rates charged to consumers range from 4d. per unit for domestic lighting to 1d. per unit for heating and cooking, while for power uses the rates may be less depending on the amount of energy consumed.*

Besides the power stations mentioned and some smaller private stations, there are a few stations owned and operated by mining companies for their own use, and totalling about 30,000 kw., and the municipal power station of Johannesburg. This station, which supplies power to the town of Johannesburg, has a rated output capacity of about 22,000 kw., the plant comprising machines ranging from 400 kw. (reciprocating) to 6,000 kw. (turbine). A 10,000-kw. set is being added, while it has been proposed by the Johannesburg Town Council to build a new municipal station of 40,000 kw.

An important addition is soon to be made to the Rand system by the establishment of a power station on the Witbank coalfields.

From this station, which is to have an initial capacity of about 60,000 kw., power will be supplied to the Victoria Falls and Transvaal Power Co. for distribution in their area of supply and direct to consumers outside of this area. It is expected that when this station is completed, power will be available at exceptionally low rates in the Witbank area, low enough, in fact, to act as a strong inducement for the establishment of electro-chemical industries under favourable conditions. It is intended to burn duff coal from the collieries in the neighbourhood which now goes to waste.

Witbank is only about 90 miles from Johannesburg on the junction of the railway lines from Pretoria and Johannesburg to Delagoa Bay. The latter line and the Rand suburban lines will probably be electrified in due course. This will greatly improve transport facilities from Witbank to the Rand and to the coast.

Pretoria is about 70 miles from Witbank and marks the western boundary of an industrial area of great possibilities. It is intended to guide developments so as eventually to build up a regional power system covering the whole area from Vereeniging on the south to Pretoria on the north, and from the West Rand to Witbank on the north-east, and as far as possible interlink the larger and more efficient stations.

The Municipality of Pretoria has recently made an important alteration in its system of power supply. The old station in the heart of the town will be used largely as a converter station, a new and modern station having been built recently on the western side of the town. Although this station is only of 10,000 kw. capacity, it is designed on modern lines, and a relatively high degree of efficiency is expected of it.

(b) The Natal System.

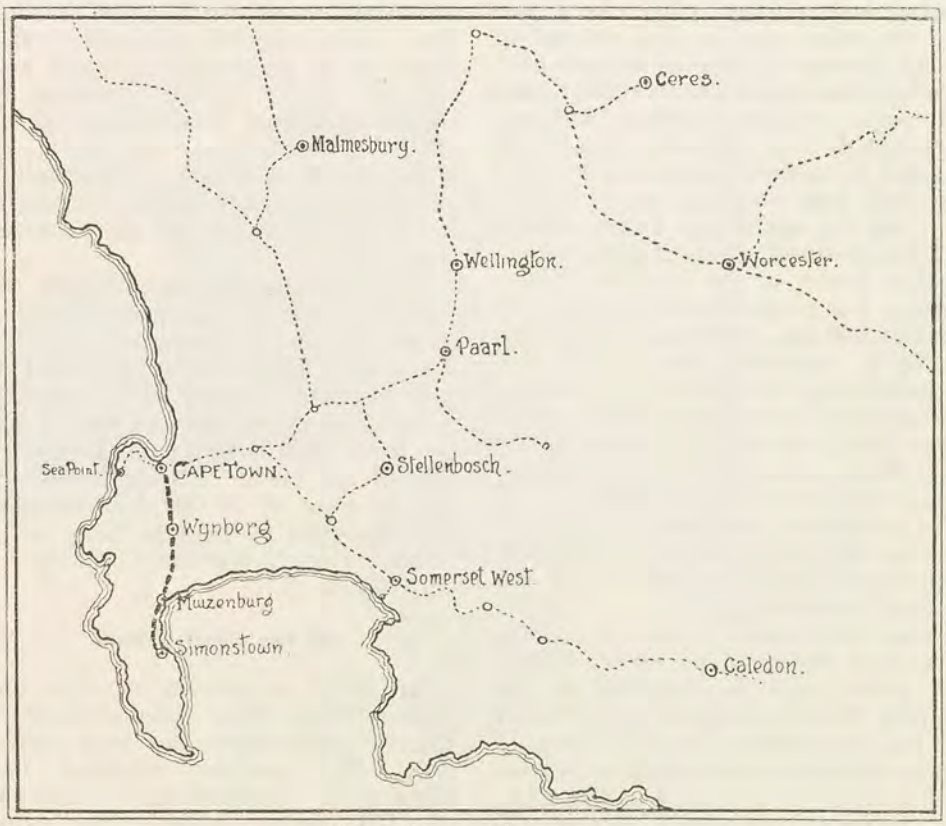
In Natal a portion of the main railway line from Johannesburg to Durban (500 miles) has been electrified. This portion stretches from Glencoe to Maritzburg, a distance of 174 route miles. The power station, to comprise initially five turbo-alternators of 12,500 kw. normal rating each, has been built by the Railways Administration on the Tugela River at Colenso. This station has been taken over by the Electricity Supply Commission to furnish power to the Railways and other consumers.

Extension of the electrified portion to Durban will require another power station, which may be erected at or

* For further information on this system, see papers by Hadley, *Journal I.E.E.* (England), Part 220, Vol. 51, 1913; Bernard Price, *Journal S.A.I.E.E.* (Johannesburg), November, 1916; T. H. Harris, Transvaal, S.A.I.E.E., August, 1922.

near Durban and linked to the Colenso station, about 185 miles to the north-west.

When this plan is carried out and proper provision made for supplying power to industries, Natal will have a power system which can be expected to have a pronounced effect on the industrial development of that part of the country.



S.W. Cape Province.

------ = Railways.

The industries in and around Durban are at present supplied from the municipal station, which has now outgrown itself and cannot be profitably extended on the present site. This is due largely to the marked developments that have taken place in this part of the country and the inducements offered by the Durban Corporation to encourage the use of electricity. Consideration is at present being given to the whole question of power supply in Durban and surroundings, and is likely to result in power being available at a cost considerably lower than has hitherto been possible, thus adding much to the advantages which Durban already possesses for industrial expansion.

(c) The Cape Peninsula.

This area, which comprises the city of Capetown and suburbs and adjoining municipalities stretching mostly

along the Peninsula from Sea Point to Simonstown, was until recently supplied with power from a number of stations of various sizes. As a result of changes that have been effected during the past few years, a large proportion of the area is now supplied from the Capetown municipal station. The tramway companies, however, operate their own stations.

The municipal station has recently undergone drastic alterations, with the result that it has been effectively modernized and the efficiency has been raised to a relatively high standard. The station at present comprises an installed capacity of about 14,000 kw., while a new 7,500-kw. turbine is on order.

The Electricity Supply Commission has taken steps for the erection of a power station on the shore of Table Bay, mainly to supply power to the Railway Administration for operating the Cape suburban lines, which are being electrified.

The proposed station will probably be linked to the municipal station, thus ensuring an economical supply system.

Industrial Possibilities.

The three areas discussed above are the most important industrial areas of the Union. It is therefore all the more necessary that power supply development in these areas be carefully guided. With the carrying out of the plans now contemplated by the commission, the industrial potentialities of the Union will be greatly enhanced. The Union possesses raw materials which, given cheap power, would make possible the manufacture of commodities which are being used in South Africa in fairly large quantities. It is hoped that when the Witbank power undertaking is fully established, power will become available at such low rates as to make manufacture for export possible.

The coal deposits of the country are extensive, and mining is carried on under conditions which make it possible to bring coal to the surface at very low cost. The pit's mouth price (1922) of South African coal mined in the Transvaal and Natal can be seen from the following table, which also gives the analyses of the coal:*

The prices given are for good "saleable" coal. A considerable proportion of good quality fine coal is at present being dumped, but will to a large extent be used in future for steam-raising in power stations.

Extensive iron-ore deposits occur in close proximity to the coalfields. For example, at Pretoria is a deposit calculated to contain about 30 million tons of ore, averaging from 45 per cent. to 55 per cent. of metallic iron. A large proportion of the ore is capable of open-cast and adit mining and can be

Province.	Price (Pit's mouth).	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Calorific Value (Mahler Bomb).
	s. d.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Transvaal...	5 7·34	0·94–4·5	22·4–30·4	52·5–60·6	12·3–17·5	1·0–1·5	12·0–13·0
Natal.....	9 2·8	8·56–2·0	20·8–30·4	64·5–70·0	7·3–11·4	1·48	13·8-15·2

* The figures show the range of values obtained for different collieries. For fuller information on the Union's coal resources, see Mellor, Transvaal Geological Society of South Africa, Vol. 25, 1922; Wybergh, Geology Survey Memoir, No. 19 (Pretoria), 1922 (a second volume in preparation).

run by gravity to the site where it is proposed to establish the ironworks, on the western outskirts of the town. The workability of the ore has been proved with an experimental plant erected on this site and having a capacity of 10 tons of pig per day. Working on this small scale, the cost of mining and delivering the ore into the furnace was estimated to range from 3s. 6d. per ton for open-cast to 12s. per ton for underground mining. The estimate was made when wages and materials were about at the peak.

A more valuable deposit has been investigated about 100 miles north of Pretoria, on the route of a proposed railway. A preliminary analysis by Dr. Moir, Government Analyst, gave the following results:—

	Per Cent.
Fe_2O_3	93·5
FeO	2·3
SiO_2	3·35
Sulphur	0·0
Phosphorus	0·05

yielding 67.3 per cent. metallic iron.

This deposit is extensive and easily mined.

Iron and steel works that have been operating for a number of years at Vereeniging and Dunswart have been successful. These plants treat mostly scrap.*

The two fundamental requisites for an industrial area, coal and iron, are therefore not lacking. In fact, both are obtainable at exceptionally low cost. When cheap power becomes available, better transport facilities can be expected as the result of electrification of the railways, which must follow in a natural course of development.

Not the least important of the main requirements for industrial development is water, with which unfortunately this part of the country is not so well endowed. The rainfall in this region is from 25 inches to 35 inches, but rain falls mostly during the summer months and is often torrential, while evaporation is relatively high.

Several places are, however, to be found where considerable quantities of water could be impounded. It is not uncommon to find miniature winter streams regularly become fair-sized and rapid flowing rivers in summer.

An example is to be found in the Hartebeestpoort Dam, about 20 miles west of Pretoria, which was completed recently and impounds the waters of the Crocodile River.

At the site of the dam this stream in winter hardly deserves the name of a river, but the dam, which holds about 32,000 million gallons, was filled during the first rainy season.

The main source of water supply in the Witbank area is the Olifants River, which is a small stream, but the contours of which make impounding possible in several places at low cost.

The following figures show the quantity of water passing down the Olifants River at Witbank during the hydrographic years (October to September) mentioned:—

Year.	Annual Discharge, in Million Cubic Feet.
1906–07	7,192
1907–08	1,229
1908–09	14,826
1909–10	3,769
1910–11	4,765
1911–12	887
1912–13	1,025
1913–14	322
1914–15	4,523
1915–16	2,889
1916–17	1,585
1917–18	26,018

* Information on iron and steel in South Africa is now fairly extensive. A good bibliography is to be found in the *South African Year Book*, 1921, page 625. See E. Bury, *S.A. Journal of Industries*, page 430, 1921; G. H. Stanley, *S.A. Journal of Industries*, Vol. I, pages 296-320; P. A. Wagner, Transvaal Geological Society, S.A., page 118, 1920; Geological Survey Memoir, No. 17, page 65 (Pretoria), 1921. Further information obtainable from the Department of Mines and Industries, Pretoria.

This river therefore, unfortunately, does not bring down what may be called a large quantity of water. For ordinary purposes, however, a plentiful supply of underground water is available.

The flow of the Vaal River at Vereeniging is given in the following table:—

Year.	Annual Discharge, in Million Cubic Feet.
1900–01	34,950
1901–02	36,176
1902–03	16,184
1903–04	77,582
1910–11	86,092
1911–12	41,592
1913–14	14,278
1914–15	152,334
1915–16	102,406
1916–17	46,158
1917–18	522,303
1918–19	83,709
1919–20	28,707
1920–21	58,372

Forty miles of the Vaal River, 20 miles on either side of Vereeniging, are taken up by a reservoir for supplying Johannesburg with water for domestic and industrial purposes.*

Considering together the availability of coal, iron, water, transport facilities, and cheap power, and the geographic position of the Vereeniging-Rand-Witbank area in relation to the principal home market (the Reef), the coast (Delagoa Bay), and a wide range of raw materials, it must be concluded that the industrial potentialities of this area cannot be ignored and are, indeed, worthy of careful investigation.

Among the electro-chemical industries that are capable of success when cheap power becomes available are nitrogen fixation, electrolytic caustic soda, electrolytic copper refining, calcium carbide, cyanamide and sodium cyanide. (The gold mines on the Rand form probably the largest consumer of cyanide in the world.)

The Natal power system which is now under construction is on the south-eastern edge of the coal deposits. Iron deposits also occur in this region, and an iron and steel industry is already established at Newcastle. Power will not be obtainable from this system at as low rates as at Witbank, but Natal offers other advantages, such as water and proximity to the coast. Three rivers, the Tugela, Mooi, and Bushmans Rivers, flow within an economic supply radius of the Natal power system.

An idea of the flow of the Tugela River at Colenso, where the power station is being erected, can be obtained from the following:—

1914—April, 329 cusecs.†
September, 29 cusecs.
1923—February, 89,400 cusecs.
April, 350 cusecs.

The month of February falls within the rainy season; April and September at the beginning and end of the dry season respectively.

The industrial growth that has taken place in and around Capetown during the past five or six years indicates that this area is capable of considerable development. Probably the main primary industry of Capetown's hinterland will be fruit-growing, for which the climatic conditions leave little to be desired. In this part of the country the rainy season is in winter, and water is plentiful. The area shown on the map (page 42) contains large stretches of land capable of producing fruit in considerably greater quantities than at present.

In this connexion it may be mentioned that the Rand-Witbank area described above is almost in the heart of the Transvaal maize belt, while Natal can feel assured of big possibilities as a result of the cotton-growing developments that are taking place at present. Until recently the

* For information on water resources, see Kanthack, *S.A. Journal of Industries*, Vol. III, 1920.

† 1 Cusec=1 cubic foot per second.

mainstay of the Union has been to a large extent the mineral industry, but farm products are rapidly taking an increasing share in the primary production of the country, and of these maize, cotton, and fruit, for the growing of which South Africa can claim exceptional qualifications, will rank among the most important. It can naturally be expected that manufacturing industries will grow in proportion to the growth of the primary industries. In the expectation of this it is wise now to guide the development of the power supply industry in such manner that in South Africa one of the essential requirements of manufacturing industry, namely, cheap power, shall not be lacking.

To work with this end in view, making use of the dearly bought experiences of other countries, and bearing in mind the present and future requirements of South Africa, is the aim of the Electricity Supply Commission.

CHAPTER VIII.

OIL PRODUCTION IN THE FUTURE.

PROSPECTS OF A SOUTH AFRICAN OIL AND SPIRIT INDUSTRY.*

THE importance of oil and its increasing consumption is one of the notable features of industrial progress. Factories and mines would close down and transport would cease if supplies were not available, while a shortage of oil would cause serious inconvenience and higher costs.

The requirements of the Union will be seen from the following imports for the year 1925:—

Article.	Quantity. Gallons.	Value. £
Motor spirit.....	34,004,000 ..	1,762,430
Paraffin.....	10,952,784 ..	527,948
Fuel oil.....	3,067,765 ..	35,473
Lubricating oil.....	4,255,466 ..	434,744
	lb.	
Paraffin wax.....	20,023,138 ..	299,531
Grease.....	5,203,009 ..	71,487

A large proportion of the fuel oil is retained at the ports for marine purposes, while the paraffin wax is utilized for the manufacture of candles. The principal feature of the imports is the increase in the use of motor spirit, which, in 1912, slightly exceeded 2,000,000 gallons.

In 1913, Mr. E. H. Cunningham Craig prepared a report† dealing with the prospects of obtaining mineral oil in the Union of South Africa. His report in this respect was discouraging, but he was of opinion that an oil-shale industry might be successful. The work that has been done during the past few years in connexion with oil shales and other bituminous deposits had been placed on record by the Department of Mines and Industries.‡

Further inquiries as to the prospects of manufacturing oil and spirit from the raw materials available in South Africa are being made by the Industrial Alcohol Committee and the Oil Fuel Committee.

There have been numerous and sometimes alarming references, both in the daily Press and technical journals as to the possibility of a shortage of oil in the near future. A statement§ was made some two years ago by Mr. J. O. Lewis, Chief Petroleum Technologist to the United States Bureau of Mines, which pointed out that the United States was then producing two-thirds of the world's output, and that 40 per cent. has been brought to the surface. The remaining 60 per cent. was insufficient for twenty years at the present rate of consumption. On the other hand, Mr. Lewis stated that the United States reserves have been depleted in a ratio far beyond that of other countries, and that geologists believe that the world contains enormous reserves of oil that can be obtained upon demand.

In March, 1921, the American Association of Petroleum Geologists co-operated with the United States Geological Survey in order to report on the oil prospects. They estimated

* By Herbert J. Ibbotson, M.Inst.G.E.

† "Report on the Petroleum Prospects in the Union of South Africa" (Government Printing Office, Pretoria).

‡ "Oil-yielding Rocks in Union of South Africa," by T. G. Trevor, A.R.S.M. (Government Printing Office, Pretoria).

§ "Motor Fuels," by Eugene H. Leslie (The Chemical Catalog Co., Inc., New York).

that the oil reserves of the United States were 9,150,000,000 barrels of 42 gallons. The marketed production of crude oil for the year 1921 was 469,000,000 barrels. The output for the whole world in 1910 was 327,500,000 barrels, and in 1921, 760,000,000 barrels, an increase of 130 per cent.

The estimates generally include only oil recoverable under the present methods of working, and it is regarded as practically certain that the yield of American oilfields will be greatly increased by new methods of recovery. Particular attention is called to the fact that certain wells will yield oil for more than a quarter of a century, and that other wells will not have been drilled by 1950.

A further important factor is the improvement in refinery efficiency. The motor spirit obtained from crude oil has increased from 9·3 per cent. in 1909 to 27·7 per cent. in 1921.

Automobile engine efficiency has also increased, and the motor spirit consumed per vehicle fell from 14·3 barrels in 1915 to 10·4 barrels in 1921.* It is unlikely that this decrease is due to a smaller mileage per vehicle.

Change of Control of the World's Resources.

One of the most interesting features of the oil market is shown by the remarkable change of control of the world resources. According to the *Financial News*,† 20th February, 1920, the British share of the oil resources of the world was about 2 per cent. at the commencement of the War. Six years later, Admiralty calculations placed the British share at 56 per cent. The *Financial News* includes British interests in South America, and states that our present command is not less than 75 per cent. of the total. Changing conditions are also indicated by American statistics, which show that in 1921 the United States of America imported 125,000,000 barrels of crude petroleum and exported less than 9,000,000 barrels.

The writer has been unable to obtain any evidence, comparable with that of the United States Geological Survey, by independent bodies of experts, relating to the probable reserves of the well-known oilfields other than those in the United States of America. This is doubtless due to the difficulty of forming reliable estimates before a large development has taken place. There is therefore no absolute proof that we are not approaching the peak of the world's oil production. Any slight diminution of output must be considered in relation to the increasing use of oil, which has more than doubled in ten years.

In this respect the quantity of fuel oil required for marine purposes is an important factor. Nearly all the modern warships are constructed to burn oil, and there is a notable increase in its use by the Mercantile Marine. The Union-Castle Company has placed in commission a 20,000-ton mail-boat, which is equipped with Diesel engines; while several other shipping companies are actually removing steam-turbines and reciprocating engines and replacing them by oil-engines.

A small or even temporary decrease in output would cause a sharp rise in prices. Every industry in the world would compete, and there would be a marked tendency for consumers to increase their stocks and to provide storage. They would take every precaution to minimize the risk of a temporary shortage. Even if this position is improbable, the mere possibility shows ample justification for taking every step that science can suggest to anticipate and, in due course, to contribute something to the falling curve. It may not be necessary, and it might not be profitable,

* "Motor Fuels," Eugene H. Leslie.
† *Financial News*, London.

for South Africa to depend on her own resources in the immediate future, but it is important that all raw materials suitable for the manufacture of oil and spirit should be examined. The quantity available and the quality should be determined, and information collected as to all known processes, with particular reference to South African conditions.

Raw Materials in South Africa.

The raw materials that are available or that could be produced for the manufacture of oil and spirit may be divided into two groups. The first of these is vegetable matter, suitable for the production of alcohol, and includes molasses, grain, and potatoes. The second group comprises carbonaceous deposits, including bituminous coal and shale.

The Natalite Company have demonstrated that a satisfactory motor spirit can be manufactured from molasses, but even if all the molasses in Natal were treated for this purpose, the quantity of motor spirit obtainable would be a small fraction of what is required.

Fortunately, South Africa can produce a cheap raw material in the form of maize that is suitable for the manufacture of alcohol, and it is estimated that 10 to 15 per cent. increase in the yield of maize would be sufficient to provide motor spirit for the present requirements. It is not suggested that fuel alcohols could be manufactured profitably from maize, to compete with petrol at its present price, without an assured market for residues at good prices.

It is, however, necessary to consider the several other forms of oil that figure in the imports, and which are essential for heating and manufacturing purposes: moreover, hydrocarbon spirit manufactured from bituminous coal and shale is desirable for the manufacture of fuel alcohol.

It has been shown that the oil-yielding rocks occur in the highest and lowest divisions of the Karroo System, which embraces a maximum thickness of 25,500 feet.* Their occurrence is also recorded at various points 500 miles apart. The development work that has been done shows that there are millions of tons of rich oil shale, and satisfactory indications of larger quantities in areas that have not been prospected.

The manufacture of oil from shale has been an established industry in Scotland for over sixty years, where the quantity treated is about 3,000,000 tons per annum. The products of this industry include motor spirit, paraffin, fuel oil, lubricating oil, grease, paraffin wax, and ammonia. These fractions are similar to the materials imported, and they can replace the products of free mineral oil, with the exception of the lubricating fraction, which is usually light, and which in some cases requires blending with viscous oils to produce the heavier grades of lubricating oil.

Oils and Spirits from Coal.

Research work has been carried out for many years in connexion with the production of these oils and spirits from coal. Laboratory work proved many years ago that they can be produced from coal under certain conditions in which temperature plays an important part, but difficulties have been experienced in producing oils of a suitable quality and at reasonable cost.

The technical difficulties include the low conductivity of coal, the tendency of oil vapours to crack and change their composition in contact with heated surfaces, and the refining of the resultant crude oil.

The problem is further complicated by the fact that no two deposits of coal are alike; even if two are

* "Oil-yielding Rocks in the Union of South Africa."

selected that are proved to be practically identical on analysis, it frequently happens that, on exposure to heat, they show very marked differences in their behaviour, due to physical characteristics. The bituminous shales may be classed with coal as regards their variations, and the commercial method of treatment has not yet been solved in regard to certain qualities.

Technical obstacles gradually merge into those of an economic nature since it is necessary not merely to produce oil from coal, but to produce it at a reasonable cost. The economics of the manufacture of oil from coal will be apparent from an examination of the average products obtainable from a good bituminous coal at low temperatures. The following figures show the thermal recovery:—

	Per Cent.
Refined oil and spirit	6
Rich hydrocarbon gases	15
Soft coke (coalite)	70
Ammoniacal liquor, tar, and loss	9
	100

The net recovery of heat will be about 15 per cent. less than the above on account of the portion required for heating the retorts.

The production of cheap oil from coal depends upon a good market for coalite and gas, which will represent 85 per cent. gross or 70 per cent. net of the original heat-units in the coal. The value of these heat-units will depend upon the locality in which they are produced, as neither gas nor coalite are convenient forms of potential heat for transport over great distances.

A ton of coal treated at low temperatures for the manufacture of oil will produce about 4,000 cubic feet of gas of a high calorific power,* which would undoubtedly have a large market for heating purposes and would be of great value to any community. It would, however, be expensive to pipe this gas, even at high pressures, over great distances from collieries to industrial and residential centres. A ton of coal treated as above will also produce some 1,400 lb. of coalite, and this fuel calls for special reference as it is not well known.

Coalite.

Coalite is a soft coke produced under the low-temperature conditions that are necessary for the production of oils from coal. It contains about 8 per cent. to 10 per cent. of volatile matter, and is superior to either coke or coal for domestic purposes. It ignites more freely than coke, and it is much cleaner than coal, as it is practically smokeless. The value of coalite has always been one of the principal claims of the advocates of low-temperature carbonization.

There has been no regular supply of coalite, as the various attempts to manufacture oils from coal have been commercially unsuccessful. On the other hand, moderate supplies have been produced intermittently from various sources during the past twenty years, and have been readily sold at good prices. This fuel is not only entirely suitable for domestic purposes, but atmospheric conditions in towns would be greatly improved by its use. Coalite is usually somewhat softer than coal and coke, and consequently is liable to deterioration with excessive handling. This defect will in future, and when necessary, be remedied by briquetting with pitch, which will remain as a residual after refining the oils. The quality will vary with different coals, and particular attention is being given to the subject of the quality and hardness of coalite by H.M. Fuel Research Department. Progress has been made by blending coals, and the importance

* Sir Geo. Beilby, "Reports of H.M. Fuel Research Board" (H.M. Stationery Office, London).

of this subject in connexion with the manufacture of oil from coal is apparent from the attention that is being given to it.

It is necessary to consider the value of both gas and coalite.

The former would represent about 4,000 cubic feet per ton, and its high calorific value makes it equal to 8,000 cubic feet of coal-gas. The value of this gas in bulk (irrespective of distribution charges) would be 4s. per 1.000 cubic feet, or 16s. per ton of coal carbonized. This is equivalent to coal-gas of 450 B.Th.U.'s per cubic foot at 2s. The quantity of coalite obtained would be 1,400 lb.; if 300 lb. is deducted for heating purposes, the remainder, 1,100 lb., would be worth 20s. per ton, i.e. 11s. per ton of coal carbonized.

These values apply to the Witwatersrand; the value of heat-units at the Cape is higher owing to the cost of transporting coal over 1,000 miles of railway.

Gas and coalite together would therefore yield 27s. per ton of coal, and assuming that the yield of refined oil and spirit is 12 gallons per ton, the value of the by-product heat-units would reduce the cost of the oil and spirit by no less than 2s. 3d. per gallon. If the yield of refined oils were 8 gallons per ton, the credit for heat-units would reduce their cost by 3s. 4½d. per gallon, as compared with costs in a remote colliery district where the heat-units would have no value.

Objections may be made to the reference to 12 gallons of oil and spirit per ton of coal with a suggestion of only 8 gallons. Laboratory results sometimes show over 30 gallons of crude oil per ton, but the refined fractions will always be much less, and operations on a commercial scale are very different to laboratory figures.

A further reason for the low estimate of the yield of oil is due to the composition of coalite, which must contain 8 per cent. to 10 per cent. of volatile matter to make it superior, for certain purposes, to both coke and coal. It would not be profitable to extract this volatile matter, apart from the question of the quality of the coalite, as the through-put of coal per retort unit would be greatly reduced and the capital charges would be higher.

In order to consider the advantages of carbonizing coal near to an industrial and residential district, it is necessary to review the alternative proposal of carbonization in a South African colliery district. Under such circumstances the heat-units might be used for steam-raising purposes on large power plants designed for electrification and other purposes. These power plants obtain coal, including duff and waste coal, at, say, an average of 5s. per ton. They could use the surplus heat from a low-temperature oil-producing plant, and as this would represent about 70 per cent. net of the total heat of a ton of coal, its value to the power plant would be approximately 70 per cent. of 5s., or 3s. 6d. In some instances it would be less, but there would also be a further saving in respect to the cost of railage on coal; under these conditions the oil would have to be transported to the centres of distribution. It is, however, very probable that new coal areas would be developed for oil-producing purposes, as special coals would be selected, and in these circumstances there might be no sale for the heat-units, and it would be more economical to transport the coal to industrial centres rather than the coalite, oils, and any other by-products obtained which would occupy more space than the original coal.

It would also be advantageous if an oil plant were situated in a position suitable for purchasing coal from a number of collieries. This would facilitate the mixing of coals, which is often important, and the sources of supply would be expanded by research work.

The Question of Choosing a Site for Future Oil Plants.

There is a strong case for the carbonization of coal near to industrial centres, but the particular merits of every proposal would have to be considered. It is possible to say definitely that in order to produce cheap oil from coal, the heat-units must be sold in a form and in a market where they possess a special value. This principle applies to all known methods of carbonization and gasification of coal, and several large plants erected in South Africa have been closed down because there has been little or no value for their surplus heat-units in colliery districts. The sale of this heat for steam-raising purposes is not likely to solve the difficulty, as a unit of heat in the form of gas, coke, or coalite is of no greater value to a power plant than a unit of heat in the form of duff or waste coal.

Particular reference has been made to coal* as there are thousands of millions of tons available, whereas only a few million tons of shale have been definitely proved to be suitable. Shale and other similar deposits will always be treated at the mine, as owing to their composition, including frequently a large percentage of ash, there is no surplus heat beyond what is required for carbonization and refining. To compensate for this there is usually a higher yield of oil, and further revenue, under favourable conditions, from ammonia and other by-products.

Waste in Burning Raw Coal.

It is hardly necessary to refer to the appalling waste that occurs with every ton of raw coal that is burnt. There has been so much publicity given to this fact that it must be fully recognized. There is, however, another equally important factor that is not realized in South Africa as it is in thickly populated countries.

The combustion of raw coal is injurious to health,** partly because it pollutes the air we breathe, partly because it hangs over our towns and cities and deprives our inhabitants of the beneficent effects of sunlight. It increases the cost of cleansing and decoration. The measurable damage in Salford and Manchester is £1,000,000 annually.† A similar estimate for London is £4,000,000,‡ but the actual damage is greater, as much is incapable of valuation.

§Domestic fires are the chief offenders, and the quantity of soot produced is 6 per cent. of the coal consumed. This is injurious to health, to vegetation, and to buildings.‖ For some years prior to 1886 the number of foggy days in London averaged eighty-six. In 1913 this figure had fallen to ten, and this is attributed to the replacement of raw coal by the products of carbonization.§

Johannesburg uses approximately 200,000 tons of coal per annum,¶ apart from the large power plants and railway requirements. If a shortage of oil occurs, this coal, plus an additional quantity to compensate for the oil extracted and the thermal losses, will be carbonized and will produce 2,500,000 to 3,750,000 gallons of oil. The refinery would probably receive crude oil from other sources. The quantity of coal treated on the Witwatersrand and in other industrial

* W. J. Wybergh, Geological Survey Memoir, No. 19 (Government Printing Office, Pretoria).

** The Right Hon. Lord Newton, P.C., *The World's Work*, February, 1923.

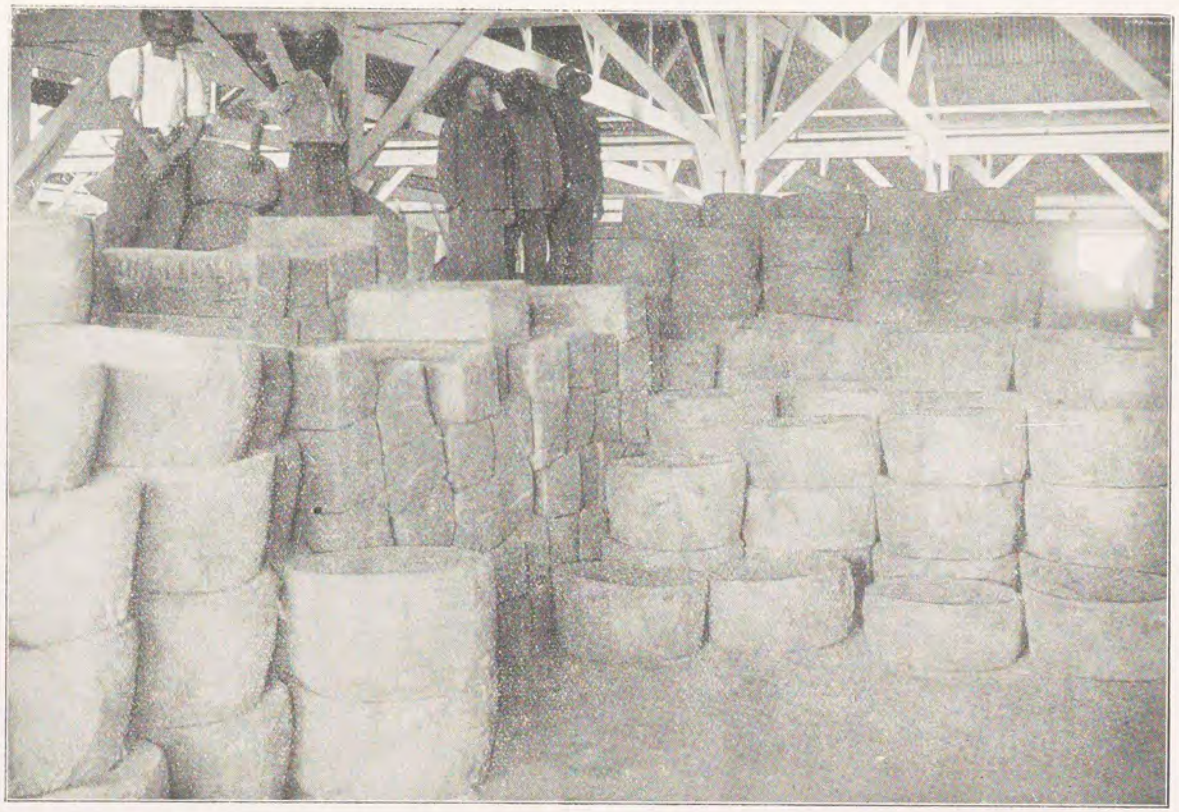
† Manchester Corporation Air Pollution Board.

‡ British Association Meeting, 1915.

§ Cohen and Ruston, *Journal Soc. Chem. Ind.*, 1911, 1,360. H.M. Fuel Research Board (1923 Annual Report) states that in extreme cases the theoretical heat-loss is 25 per cent. to 30 per cent.

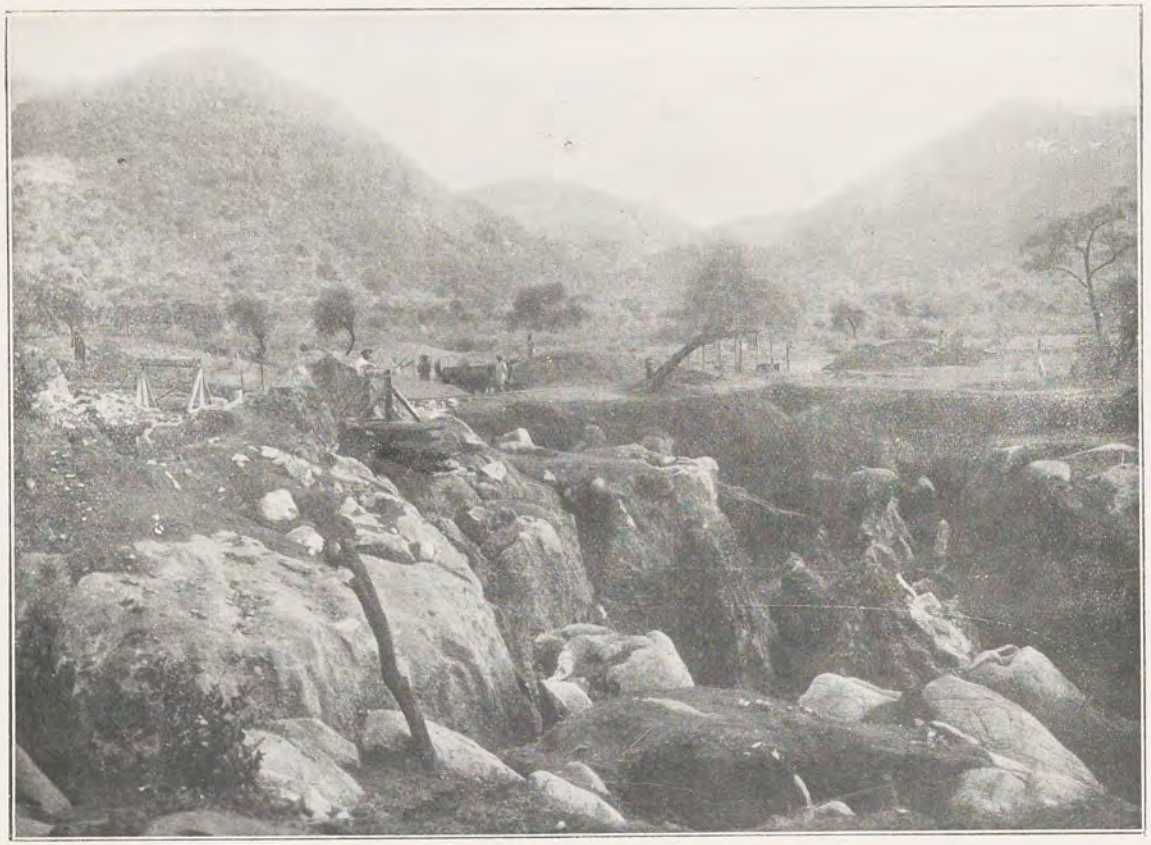
‖ Sir W. Bennett in "Coal Fires and Fog," *Gas Journal*, 1913, 124, 113.

¶ Estimated from S.A.R. records; no definite figures available.



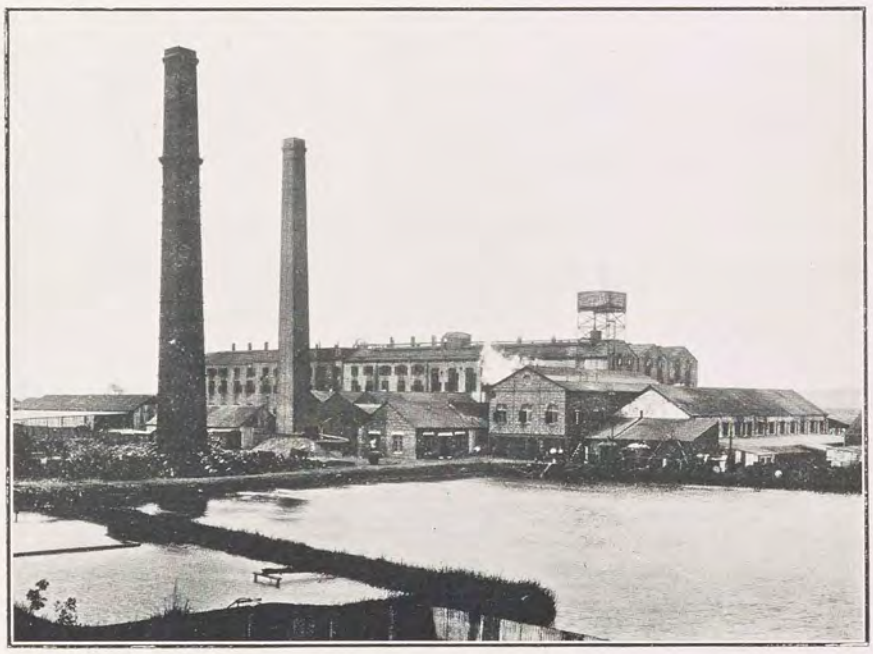
BEES-WAX FOR EXPORT.

Considerable quantities of bees-wax are now being produced. There is an export trade in this product, and above is shown a consignment of wax awaiting shipment.



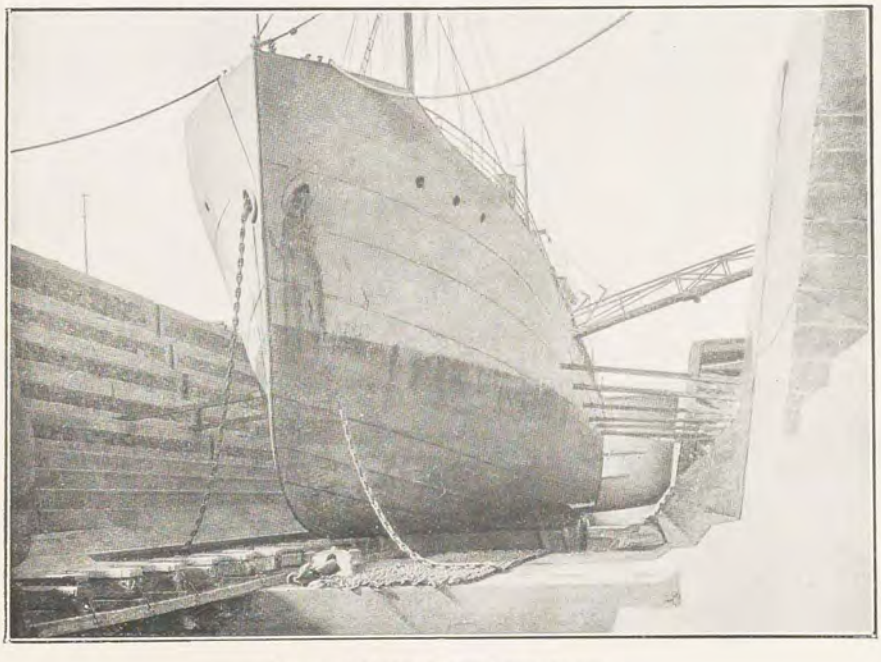
A Vanadium Mine in South-West Africa (Bobcs, Tsumeb).

General View of the Industrial Area of Congella, Durban.



South African Sugar Refinery, South Coast Junction, Natal.

ADDERLEY STREET, CAPETOWN.



ALBERT BASIN, CAPETOWN DOCKS.

centres would have to be in proportion to the requiremente of the community in regard to gas and coalite, more particularly the former. These are matters of detail and development, and are not insuperable difficulties.

If coal is carbonized in localities that do not permit every surplus heat-unit being sold in the best market, the cost of oil will be so high that it would be imported from countries that did manufacture it under the most favourable conditions.

Tar, tar products, and ammonia are imported to South Africa to-day because this principle has been neglected in many instances, and in this respect there is no difference whether carbonization is conducted at high or low temperatures.

Advantages of the Establishment of a South African Oil Industry.

If the future is anticipated, the threatened restriction of oil supplies, when it occurs, may well be of advantage to South Africa, and not a calamity as it is usually regarded. The money that leaves the country to purchase oil will be retained, domestic and industrial heating will be cleaner, more efficient, and economical. The full development of this industry would mean distinct but beneficial changes in the supply of heat, while the manufacture of fuel alcohol would almost certainly be associated with better and more intensive agricultural conditions.

The experience of others engaged in this class of work and an examination of their working costs has proved definitely that the operations must take place on a large scale in order that the cost of technical and skilled staff can be divided into a large output. This has the effect of making the preliminary work very expensive, as large areas of raw material have to be acquired and proved for mining purposes, while overseas tests on a commercial scale have to be made and sometimes repeated, before any attempt can be made to design plant and estimate working costs. This work is complicated by the variations of bituminous deposits and differences in the chemical composition of the crude distillates.

Refining Imported Crude Oil in South Africa.

A suggestion has been made that should materially reduce the above-mentioned difficulties. The proposal is that an oil refinery be erected at the coast for the purpose of refining imported crude oil. There are precedents for this suggestion on a sufficiently large scale to justify fully its consideration. There are fourteen oil refineries in Canada, and a large plant near Swansea, in South Wales, has recently been erected by the Anglo-Persian Oil Company. This refinery covers 650 acres of land, and the combined storage capacity is over 75,000,000 gallons.

Another recent example of this practice has occurred in Australia.* where the Government have made a contract with the Anglo-Persian Oil Company for the erection of a refinery at Port Philip Bay. The capital of the company is £500,000, and the Government will hold just over 50 per cent. of the stock.

There are various protective clauses which provide for Australia having preference of the refined products. There is also a clause by which the company will purchase indigenous oil as it becomes available at prices to be agreed.

A contract of this description would be advantageous to the Union. It would bring capital to the country, and would assist employment, and in case

* A. Y. G. Campbell, Report on State-aid to Industries" (published by the Indian Government, 1923).

of emergency, the available stock of oil would be greater than has been the case hitherto. The most attractive feature, however, of this proposal is to regard it as a first step towards the development of an industry for refining crude oils made from South African coal and shale.

Difficulties of Establishing a Shale-Oil Industry.

Reference has been made to the difficulties of establishing a shale-oil industry, which include—

(1) expensive and lengthy research work;
(2) high capital costs owing to the necessity of operations being on a large scale.

These objections would not be entirely overcome, but they would be greatly modified if a refinery were installed in the Union.

Research work includes prospecting, carbonization and refining. The latter could be done on a commercial scale at the refinery, and repeated if necessary. This work would be comparatively inexpensive, as the technical organization would be available and the refined products would be marketable.

The capital costs of a shale-oil industry would be reduced, as it would be confined to mine equipment, carbonization and ammonia recovery plant. Storage would be reduced to a minimum, as the crude oil could be dispatched daily in tank trucks, while there would be no refinery or plant and organization for packing and dispatching.

An important feature of this proposal is that small-scale operations at existing mines and in new areas would be practicable, subject to low railway rates on the crude oil to the refinery.

The proposed plant could have a capacity of 40 to 50 million gallons of crude oil per annum. There would be no serious difficulty in regard to the comparatively small local requirements of fuel oil compared with other fractions, as the surplus fuel oil could be cracked and a proportion of it converted to petrol.

A South African refinery would result in further developments in respect to the supply of chemicals for refining purposes, and of materials for construction; this would lead to larger output and lower costs, which would be of assistance when it becomes necessary both to manufacture and refine oil and spirit from South African materials. It would also lead to the training of a technical staff, who would be available for future developments.

Packing and Transport.

During the past three years great strides have been made in the distribution of motor spirit in bulk. The Shell Co. of South Africa have established depots for this purpose at Durban, Johannesburg, Pretoria, Kimberley, Maritzburg, Benoni, Bethlehem, Capetown, Port Elizabeth, and Bloemfontein. Others are in process of erection at East London and elsewhere.

It is also known that other companies are making similar arrangements.

In fact, about 50 per cent. of the motor spirit used in this country is now distributed to pumps in returnable containers, having a lengthy life, instead of in cases holding two four-gallon tins.

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CHAPTER IX.

RESEARCH IN THE UNION OF SOUTH AFRICA.*

THE earliest scientific investigations conducted in South Africa were astronomical. In 1752, exactly a century after the landing of Van Riebeek and the beginning of the first settlement at the Cape, the Abbe de Lacaille, attracted by the obvious advantages presented for the observation of the southern heavens, arrived at Capetown, and it is to him that we owe the first extensive and accurate catalogue of the stars of the Southern Hemisphere. In 1832, Sir John Herschel visited the Cape and resided there for four years, his primary object being the cataloguing of the nebulae of the southern heavens. By this time the Royal Observatory had been established at the Cape by the British Government and a beginning made in the brilliant astronomical and geodetic work which has rendered this observatory famous.

The first accurate knowledge of the fauna and flora of South Africa was obtained through the labours of European naturalists who, towards the end of the eighteenth century, began to visit the country with the object of collecting specimens of its animals and plants and making scientific observations. Of such early travellers may be mentioned Sparrman, Thunberg, Le Vaillant, Lichtenstein, Barrow, Burchell, and Drége. A wealth of zoological information was also acquired by Sir Andrew Smith, of the Army Medical Service, in the course of his various expeditions into the interior of the country. In 1855 the South African Museum was founded at Capetown, thus for the first time affording facilities within the country for the continuous and systematic study of its natural history.

The earliest investigations of importance into the geology of the country were conducted about the middle of last century and were distinguished from those already referred to by the circumstance that they were not exotic in character, but were undertaken by a settler, A. G. Bain, appropriately known as "the father of South African Geology." Bain was already in his middle age when he took up the study of the science, but he prosecuted his inquiries with the greatest enthusiasm and success. Amongst those who followed him, the most noteworthy was G. W. Stow, also a settler. Stow has the credit of being the first to appreciate the evidence of South Africa's great ice age, but he is better known as the discoverer of the Vereeniging coalfield.

Several of the South African Governments employed geologists from time to time either to make special reports or with a view to the discovery of mineral wealth. Among those so engaged were Stow and E. J. Dunn, who made some important additions to our knowledge of the geology of Cape Colony. However, it was not till 1895 that a systematic geological survey under Government auspices was instituted in the country.

Organized research in South Africa is mostly a product of the last twenty years, and the extent to which it has been developed may be judged from the following pages. It should, however, be noted that the review there

* Compiled by a Committee of the Research Grant Board.

given of the present research activities within the Union is, with the exception of reference to anthropological and historical investigation, confined to institutions and organizations of a public character, no account being given, for example, of the work of laboratories attached to industrial undertakings.

The Research Grant Board.

The Research Grant Board was instituted by the Government in 1918. It was at first associated with the Advisory Board of Industry and Science, but is now a separate body attached to the Department of Mines and Industries and reporting to the Minister for Mines and Industries and the Minister for Education.

The duties of the Board are, generally, to advise the Government regarding the practical measures necessary for the encouragement of research within the Union, and to administer all Government grants in aid of research.

Acting on the advice of the Board, the Government has established a system of research scholarships and grants, which are administered by the Board. The scholarships range in value from £80 to £250 per annum for one or two years. The recipients are, in general, students who have already obtained university degrees and are undertaking research for the first time, under the supervision of their professors, though in some instances they are young professional men who have elected to give up the practice of their professions for a period in order to undertake research, also under suitable supervision. The immediate results to be anticipated in such circumstances are not so much valuable discoveries as the provision of a supply of young men trained in methods of research and with a taste acquired for investigation.

The recipients of research grants on the other hand are members of the staffs of the universities and others who have, most of them, a considerable amount of research already to their credit. The grants are made to defray such necessary expenses as the purchase of apparatus, material, and literature, travelling expenses, and the cost of publication of the results of research.

In addition, certain Departments of State, museums, and other institutions assist the holders of grants by permitting them to conduct their researches in the established laboratories and allowing them to utilize the equipment and other facilities existing therein.

In order to assist the Board, a report on each application for a scholarship or grant is obtained from an authority on the branch of knowledge to which the subject of the proposed research belongs. In making awards, advantage is taken of the opportunity to impose such conditions as are thought necessary to procure co-ordination and prevent undue overlapping of effort.

Since its inception the Board has allotted twenty-six scholarships and one hundred and twenty-two grants.

Department of Agriculture.

AGRICULTURAL SCHOOLS AND EXPERIMENTAL FARMS.

Schools of agriculture and experimental farms have been established at several localities in the Union, viz.:

(1) Elsenburg (Cape).
(2) Grootfontein (Cape).
(3) Cedara (Natal).
(4) Potchefstroom (Transvaal).
(5) Glen (Orange Free State).

With the exception of Elsenburg, these institutions were established during the present century. All are more or less specialized, and the members of their staffs, in addition to their educational duties, carry out experimental and research work.

The experimental work is varied and comprehensive, covering the whole field of agriculture. As regards laboratory research work, at Cedara

the tannin-content of wattle bark, the extraction of bark, the oxidation of arsenite of soda in cattle-dipping tanks, and the sugar-content of different varieties of cane, have been investigated; at Grootfontein the properties of storm-water used for irrigation purposes, and soil-alkali problems; at Potchefstroom, the methods of combating the ravages of the tubermoth on potatoes, and the theory of sex-control plant-breeding; at Elsenburg, the improvement of cereals by selection and hybridizing, wine-making, etc.

DIVISION OF BOTANY.

One of the most important lines of research in the Division of Botany is the investigation of diseases affecting plants in South Africa. At Pretoria, considerable progress has been made in the study of bacterial diseases of plants. Investigations are being conducted into the causes of wastage in export fruit.

There is a branch laboratory at Durban for the study of sub-tropical diseases, the chief subject of investigation at present being the mosaic diseases of sugar-cane and allied plants. The branch laboratory at Capetown is chiefly concerned with the diseases of deciduous fruit trees and wheat.

A systematic study of the indigenous flora is being carried out in the National Herbarium. Monographs have been published on a number of genera of the flowering plants, and more work of this kind is in progress. A special study is being made of the grasses and other groups of economic importance, especially those yielding oils, fats, waxes, fibres, and animal poisons. In the cryptogamic section of the herbarium there are large collections of indigenous and exotic fungi, and considerable progress has been made in the study of the Ascomycetes, the Polyporaceae, and Uredineae. Contributions from both sections of the herbarium are published in "Bothalia."

In addition to the systematic study of economic plants, which are sent to the Imperial Institute for analysis, indigenous grasses and fodder plants are tested at the experimental farm attached to the Division for drought resistance, palatability to stock, and resistance to frost.

The botanical survey of the Union is not strictly one of the activities of the Division, but the Chief of the Division is *ex officio* the Director of the Survey, and many of the records are kept and identifications of plants are made in the National Herbarium. In connexion with the survey, a systematic and ecological study of the flora of the various regions is being conducted by well-known botanists in the four Provinces. The results of this work are published in the "Memoirs of the Botanical Survey."

DIVISION OF CHEMISTRY.

The Division of Chemistry of the Department of Agriculture has two laboratories (at Capetown and Johannesburg) where the chemical analyses and investigations required by various Government departments are carried out.

The Division has laboratories at Pretoria and at the experimental stations at Cedara, Elsenburg, Glen, Grootfontein, and Potchefstroom, where agricultural analyses and chemical investigations of agricultural problems, both cultural and economic, are made. At these laboratories problems connected with the soil, with plants, with plant-products, and with fertilizers are being investigated.

The Division, at its various laboratories, is well equipped for carrying out chemical researches of all kinds.

DIVISION OF VETERINARY EDUCATION AND RESEARCH.

Main Function.

The main function of this Division of the Department of Agriculture is

the investigation of animal diseases in South Africa, and the devising of methods for controlling them. Once discovered, the administration of measures for control passes largely into the hands of the sister " Veterinary Division " with its staff of veterinary officers stationed at various places throughout the country.

Research on a small scale had been carried out by the earlier veterinary field officers of the Cape, Transvaal, and Natal, but it was only in 1908 that the enormous importance to the stock industry of systematic investigation into animal diseases was fully recognized by the Government of the Transvaal, and a large institute for veterinary research erected at Onderstepoort, near Pretoria. After Union this institute had to serve the whole of South Africa, and expansion therefore became necessary.

Teaching Activities.

In 1919 it was decided to establish an associated veterinary training college, and the opportunity was taken of incorporating this in the programme of expansion required in any case to meet the rapidly growing needs of the country. The research Division then became the " Division of Veterinary Education and Research," affiliated to the University of South Africa on the academic side, but remaining wholly within the Department of Agriculture in respect of its major activities. Of the five-year B.V.Sc. course, the first two years, or " preclinical training," may be taken at any adequately equipped university college in the Union, while the last three years of " vocational training " are confined exclusively to Onderstepoort.

A large proportion of the professional staff of the Division, therefore, hold dual positions; primarily as research officers in the Department of Agriculture, and secondarily as lecturers or professors of the University of South Africa, in those subjects in which they have specialized. In order to obtain a sufficient variety of clinical material for demonstration to students, sick or injured animals are accepted at the laboratory clinic—a procedure which incidentally benefits the farmers in the immediate vicinity of Onderstepoort and those sufficiently concerned to send cases by rail.

Manufacture of Remedies.

Since most of the research undertaken by the Division has a direct bearing upon the prevention or treatment of diseases of stock, the routine manufacture of vaccines, sera, and other products is undertaken as an important part of the divisional work. In the case of the commoner diseases also prevalent in Europe, vaccines were previously imported, but of late years practically all veterinary biological products required in the Union have been made at Onderstepoort. This procedure is found preferable, since standard vaccines can be supplied fresher and at lower cost, while special vaccines can be prepared to suit local conditions. Special attention has been concentrated upon diseases specially prevalent amongst South African live stock, and methods for prevention or treatment worked out for practically all of them.

The Division also undertakes the examination of blood-smears, parasites, and other specimens, free of charge. Farmers are encouraged to send material from all sick animals for diagnosis, and the results of examination are returned to them with as little delay as possible. In the case of unknown diseases, farmers frequently send sick animals to the laboratory for diagnosis or special study, so that if necessary a special vaccine can be prepared, or recommendations made concerning treatment and future prevention.

Advisory Activities.

The Division also conducts a very extensive correspondence with the

general public and gives advice or issues bulletins, on all questions relating to the health of stock.

The activities of the Division necessitate a large staff, extensive laboratory, and stabling accommodation, modern equipment, numerous experimental animals, and a liberal maintenance allowance. Fortunately, the South African Government realized that expenditure in such directions ultimately brings its return in increased agricultural prosperity, and so far has shown an exceedingly progressive spirit towards the fostering of research. The result is that the Union of South Africa to-day possesses a veterinary research institute second to none in the world, and it is possible to deal with animal diseases in a thoroughly up-to-date manner.

Forest Department.

RESEARCH AND EXPERIMENTAL WORK.

The sections of the research branch are as follows:—

(1) *Silviculture and Forest Botany.*

This section collects and distributes information, arranges further trials of exotic species, and experiments in thinnings, etc., clears up identities of exotic and indigenous trees, and so on; and its officers spend part of their time on investigations and collection of growth data in the field. The herbarium contains over 5,000 specimens. The large number of indigenous and exotic species demanding study is shown by the fact that this section now has sites for 430 of the former and 620 of the latter.

This section also deals with minor products (tanning materials, oils, fibres, etc.), as far as it can, and arranges from time to time for analyses or practical tests of materials which seem worthy of consideration.

(2) *Silvicultural Research in the Indigenous Forests of the Midland Conservancy.*

A small research station has been established at Deepwalls, in the middle of the main forest near Knysna, and investigations into the problems of regeneration, the silvicultural characteristics, and rate of growth of the principal species, etc., are being made.

(3) *Silvicultural Research and Experimental Working Plans in the Eastern Conservancy.*

A start has been made with this work at some of the oldest plantations, at which a considerable amount of useful growth data is obtainable.

(4) *Timber Investigations.*

Seasoning experiments are being conducted continuously in two seasoning kilns (one water-spray and one fan) in co-operation with the Railway Administration at Pretoria.

The officers of this section give attention to inquiries of all sorts from the public about the seasoning and treatment of woods, and to the preparation of specimens for exhibition, etc., and more up-to-date seasoning methods are now being adopted by several of the timber merchants as a result of the advice given.

Department of Irrigation.

METEOROLOGICAL OFFICE.

At the end of March, 1922, the number of observing stations directly under control of or co-operating with the Meteorological Office was as follows:—

One first order station (viz., Johannesburg), where continuous records of the principal meteorological elements are carried out by means of self-recording instruments; 86 barometric stations, 130 thermometric stations, and 2,438 rainfall stations where observations are carried out once a day, at 8.30 a.m. mean time of 30° E. longitude. There are thus altogether 2,655 stations of different classes distributed over South Africa from which monthly returns are received: of this number, 2,624 are situated within the Union and the remainder in adjoining territories.

Daily Forecasts and Weather Reports.

The 8.30 a.m. readings from 73 stations are telegraphed each morning to the Forecasting Branch, and from this material a synopsis of the existing weather conditions over the Union is prepared and a forecast for the ensuing twenty-four hours issued at 11.30 a.m. This information is distributed to the general public through the media of the telegraphs and the Press. A separate forecast for the coast is also prepared and broadcast to ships at sea by the wireless stations at Slangkop and Durban. Particulars of rainfall and the extremes of temperature during the previous twenty-four hours at the telegraph reporting stations in each Province, together with similar data for the principal towns of the other Provinces are collected and distributed by the central telegraph offices. An extension of activity in this section of the work is expected to be shortly in operation, by which wireless or cable weather messages will be received from ships at sea and from land stations in adjoining territories as far north as Moçambique on the east and Loanda on the west.

Upper Air Investigations.

Although neither staff nor facilities are provided for investigation of the wide subject of the physics of the air, several hundred pilot balloon ascents have been carried out. The data so obtained are awaiting a suitable opportunity of being worked up. Sounding-balloon ascents with meteorographs have been limited to five, four of which were carried out in the International Week in May, 1922. Two records were recovered and the results obtained were published in the Monthly Weather Report for May, 1922.

Department of Mines and Industries.

In the Department of Mines and Industries, research work is carried on by the Geological Survey and by the branch dealing with the technical inspection of mines.

Research work in the mines inspection branch is mainly concerned with questions of health and safety on mines and particularly with the prevention of miners' phthisis on the Witwatersrand mines. Methods of determining dust and of eliminating it from the atmosphere are investigated, as well as allied problems such as those bearing on ventilation. Publication of results takes place in the Annual Report of the Government Mining Engineer, and by means of papers and discussions on papers read before the several technical societies of the Witwatersrand.

The Department also assists where it can in exploring the commercial possibilities of new minerals and the markets available overseas for such minerals.

The Geological Survey carries out investigations in pure and applied geology. The main object kept in view is the preparation of a geological map of the Union. For the purpose of publication, the field-maps are drawn on a scale of 1 inch to 2.35 miles for the Transvaal, Orange Free State, and Natal, and 1 inch to 3.75 miles for the Cape Province. The district maps issued by the several Governments before Union led to the choice of the two scales, and so much work had been done on them that a uniform system could not be adopted later without inconvenience. The Cape Province will be represented on 52 sheets, of which 20 have been issued, and the other Provinces on 117 sheets, of which 17 have been published, while areas equal to 17 sheets have been surveyed, but individual sheets of these areas are incomplete or await printing. In addition to these sheets, maps of certain areas have been published on larger scales or on the larger of the two scales mentioned; thus a map of the neighbourhood of Pretoria (1 inch to a mile) was issued in the early days of the Transvaal survey on account of the interest of the faults there, and the Witwatersrand and Heidelberg (Transvaal) goldfields are printed on a scale

of 1 inch to 0.946 mile because the detail required could not be adequately shown on a smaller scale. The mining districts of Barberton, Pilgrims Rest, and the Murchison Range are represented on maps published with descriptions of those areas, which are not conterminous with sheet maps.

The descriptions of areas represented by the sheet maps are printed and issued as "Explanations," and this has been done consistently in the Transvaal, but the sheets of the Cape Province issued before the unification of the provincial surveys were not accompanied by "Explanations" as the areas had already been described in the annual reports.

A considerable part of the work of the Survey has been devoted to studies of areas of special economic interest and to investigations of groups of mineral deposits; these are published in the form of Memoirs. Another Memoir contains a bibliography of literature bearing on South African geology, and a companion volume contains a subject index of that list. The chief mining fields which have been described in Memoirs are the Witbank Coalfields, Barberton, Pilgrims Rest, and Sabie and the tin-mining districts of the Waterberg and Olifants River; while the chief mineral deposits, described somewhat exhaustively as far as known at the date of publication, are those of asbestos, corundum, and mica; coal and limestone have been considered in two Memoirs in a less complete way, because many parts of the country where they occur have not yet been geologically surveyed. The Memoirs on the Crocodile River iron ores and the Pretoria salt pan are concerned with a mining field which has not yet been exploited and a remarkable source of sodium salts, which deserved special attention both from the economic and scientific aspects. The platinum deposits of Rustenburg are the subject of another Memoir. The whole series of Memoirs was designed to provide descriptions valuable both to those who are commercially interested and to students of ore deposits.

Descriptions of the palaeontological material obtained in the course of the survey are published jointly by the Survey and Trustees of the South African Museum in the annals of that institution, where the types are preserved. The work has been done for the most part by specialists who are not on the staff.

The collections of rocks and minerals form the basis of the Geological Museum in Pretoria and of the geological collections at the South African Museum. Efforts are made to maintain these collections thoroughly illustrative of economic developments based on the mineral resources of the Union as well as of the geological formation of the country.

Samples of rocks and minerals, the sources of which are attested, are received at the Survey office for determination, and in many instances advice is given, as far as possible, by members of the staff.

A laboratory is maintained in which work is done on these samples as well as on the material brought in by the staff.

The Union Observatory.

From 1904 to 1912 the Union Observatory had served as headquarters for the Meteorological Service of the Transvaal, but in May of the latter year it was reorganized under the direction of General Smuts (then Prime Minister of the Union) as an astronomical observatory and its meteorological department was removed to Pretoria.

The chief instruments are a 26-inch visual refracting telescope (now nearly completed and partially erected); a 10-inch star-camera; a 9-inch refracting telescope, and other smaller telescopes; a seismograph; wireless receiving apparatus; and a blink-microscope for the rapid comparison

of celestial photographs. The Observatory is charged with the observation of minor planets when these are south of the equator, and several of these bodies have been discovered here, including amongst them No. 715 Transvaalia and No. 758 Mancunia. The nearest known star, Proxima Centauri, was found by means of the blink-microscope in 1915.

Measurements of proper motions, of which some 6,000 have been discovered, measurements of double stars, observations of Jupiter's satellites and occultations of stars by the Moon and planets form the main lines of activity.

The results are published from time to time in circulars which are distributed to kindred institutions and active astronomers. The publication of a series of stellar maps on the scale $1^\circ = 36$ mm. is in progress, and so far 175 maps out of a total of 556 have been distributed.

Royal Observatory, Cape of Good Hope.

The Royal Observatory at Capetown was instituted by an Order-in-Council of the British Government in 1820, and is under the control of the Admiralty.

The original object was to establish an observatory conducive to the improvement of practical astronomy and navigation in the Southern Hemisphere, where observations could be made of the positions of stars not visible at Greenwich.

With this aim in view, regular observations of the Sun, Moon, planets, and stars are undertaken at the observatory.

It was at the Cape Observatory that the idea of employing the telescope for the determination of accurate positions of stars by means of photography first took practical shape in 1882. The development of this branch of astronomy resulted in the formation of (1) the Cape Photographic Durchmusterung, a photographic catalogue of nearly 400,000 stars, and (2) the international survey of the heavens, in which many of the principal observatories of the world have co-operated. The Cape contribution to the Carte du Ciel is a catalogue of about half a million stars, which has been completed.

Among the principal instruments in regular use are—

(1) The reversible transit circle, which is used for meridian observations of stars and the subsequent formation of fundamental star catalogues.

(2) The McClean telescope, used for the spectroscopic determination of motions of stars in the line of sight. It has also afforded a determination of the solar parallax, confirming previous Cape results obtained by other methods. It has recently been used in the determination of the orbits of spectroscopic binary stars, and a further extension of its work is contemplated whereby peculiarities in certain lines of star spectra may be utilized for the determination of stellar parallax.

(3) Astrographic telescope, used for stellar photography in connexion with the Carte du Ciel. It has recently been employed in work on stellar magnitudes, the results of which give rise to many researches of a statistical nature, dealing with the motions and distribution of the stars in space.

A catalogue containing the photographic magnitudes of over 20,000 stars, standardized on a true photometric scale and systematically based on the fundamental Cape system of the south-polar area, is in the press.

(4) Heliometer, for planetary observations.

(5) Photoheliograph, for taking daily photographs of the Sun.

(6) Seismograph, giving a continuous record of earthquakes. Meteorological observations are also regularly undertaken, and daily time signals are sent over the telegraph lines to various parts of South Africa and also from Slangkop by wireless transmission to ships at sea.

The Observatory wireless receiving apparatus is extensively used for the reception of European and American time signals, and will shortly co-operate in an international scheme of longitude determinations.

Marine Surveys.

Marine investigations have been carried out by the South African Government with the aid of survey ships, the "Pieter Faure" and the "Pickle" working in conjunction with a Marine Biological Laboratory near Capetown. Various parts of the South African coast have been examined from Walvis Bay on the west coast to the northern boundaries of Natal on the east coast.

The scientific results have been published in various Government reports and in scientific journals. They deal with a variety of subjects, including both physical and biological aspects of the South African seas.

With regard to the physical aspect of these marine investigations, it has been found by numerous soundings that the South African seas differ very considerably in depth and nature of bottom. Some parts resemble the large, comparatively shallow fishing areas, such as are found in the North Sea, and have been found, like them, to abound in fish of economic value. In the other parts of the coast such areas are absent, the slope of the sea bottom being steeper and the variety of forms of life of a totally different character. All these different areas have been described in reports and laid out in charts drawn up from the survey observations. The sea-water also varies much in different localities, in temperature, salinity, nitrogen-content, etc., as shown by numerous observations made during the surveys. Current observations by aid of drift bottles, etc., have also been made at various localities.

With regard to the biological results of the surveys, the different areas examined have proved to have a great diversity of forms. On the whole, the waters of the west coast have proved to be most densely populated, while there is a much greater variety on the east coast and within those regions there are various areas with their own characteristic fauna. Between six and seven hundred species in the various groups of animals have proved to be new to science, being in the larger groups, so far examined, as follows:—Fishes, 250, crustacea 196, mollusca 107, echinoderms 92, alcyonaria 37, sponges 26. More general questions such as development, life-history, geographical distribution, etc., have also been investigated by those who have examined the material and are dealt with specially or incidentally in their reports.

The main object of the investigations on the part of the Government has been the development of the marine resources of South Africa, and also the control and conservation of the fishing industry. The results have been briefly, that several thousands of square miles of new fishing grounds have been discovered, adapted for trawling and abounding in food-fish, including sole hitherto considered a rarity in South Africa. A trawling industry has been established, and not only is South Africa well supplied with fish, but a considerable export trade is being developed with overseas countries. Investigations into the habits and life-history of fish have been the basis of adequate regulations for their conservation. It has, for instance, in the case of the Cape crayfish, of which from fifteen to twenty million are canned and

exported annually, probably saved this important industry from a fate which has befallen the lobster industry in other countries.

The South African Institute for Medical Research.

The South African Institute for Medical Research was established at Johannesburg in 1912, by agreement between the Government and the Witwatersrand Native Labour Association (acting on behalf of the mining industry of the Transvaal), for the purpose of carrying out investigations with a view to the prevention and treatment of human diseases.

The institute occupies a commanding position adjacent to the General Hospital and overlooks the central portion of Johannesburg. The site, in extent just over four acres, was donated by the Government, whilst the cost of the buildings and their equipment, amounting to about £45,000, was borne by the mining industry.

The cost of mantenance is met by contributions from the Government and the Witwatersrand Native Labour Association in addition to the revenue earned by the performance of bacteriological and pathological services.

The work of the institute is carried on in two divisions—Research and Routine.

The most prominent line of research which up to now has been pursued in the research division is that in respect of the prevention of pneumonia, a disease which until recently accounted for most of the sickness and mortality among the native labourers on the mines of South Africa. In connexion with epidemic influenza a filterable virus has been obtained from the nasopharynx of patients and has been cultivated through many generations on artificial media. Experiments have been carried out on human volunteers to determine its etiological relation to the disease, but so far with inconclusive results. A somewhat similar virus has been recently isolated at the Institute from the blood of horses suffering from African horse-sickness. A considerable amount of work has also been, or is in process of being, carried out in connexion with such diseases as silicosis, tuberculosis, bilharziosis, and cerebro-spinal meningitis, as well as in the domain of pure bacteriology. The results of these investigations are to be found in the " publications " of the Institute, of which eighteen have been issued, as well as in papers contributed by members of the staff to technical journals.

The Routine Division carries out a large amount of diagnostic investigation for hospitals and the medical profession, in addition to the usual bacteriological services required for the Government, the mining industry, and municipalities.

Since the establishment of the Miners' Phthisis Medical Bureau in 1916, its work has been carried out in the Institute buildings. Under the Miners' Phthisis Act of 1916, every applicant for employment underground in the mines of the Witwatersrand is required to submit himself for medical examination at the Bureau, and in addition all miners employed underground must be examined at intervals of six months. The association of the work of the Bureau with that of the Institute has proved of mutual advantage; pathological investigations required by the Bureau being carried out without loss of time in the adjacent laboratories, while unique facilities for investigating miners' phthisis are thus provided.

National Botanic Gardens, Kirstenbosch.

The National Botanic Gardens were established in 1913, due largely to the efforts of the late Prof. H. W. H. Pearson, who became their first director. The gardens are situated at Kirstenbosch, near Capetown, and occupy about 1,100 acres on the eastern slope of Table Mountain.

The greater part of this is a nature reserve, including examples of many ecological types of vegetation. In the cultivated part of the gardens is a magnificent collection of South African indigenous plants, largely named by the staff of the Bolus Herbarium and available for study by research workers and students. In the economic section is a comprehensive collection of medicinal and aromatic plants available for pharmacological research. A sub-station of forty acres at Whitehill, near Matjesfontein, has recently been established as a Karroo garden.

The National Botanic Gardens are closely associated with the University of Capetown, one of the Professors of Botany being the Director. They are under the control of a Board of Trustees, and the funds are chiefly derived from Government and municipal grants, and from voluntary subscriptions through the Botanical Society of South Africa.

Museums.

Museums, which are largely supported by Government grants, have been established in all of the principal towns of the Union, excepting Johannesburg.

They are as follows:—

South African Museum, Capetown; established 1855.
Transvaal Museum, Pretoria; established 1893.
Natal Museum, Pietermaritzburg; established 1903.
Bloemfontein Museum; established 1877.
Albany Museum, Grahamstown; established 1855.
Port Elizabeth Museum; established 1883.
Kingwilliamstown Museum; established 1898.
McGregor Museum, Kimberley; established 1906.
Durban Museum; established 1887.

In all the museums research is being carried out, which generally takes the form of systematic studies of the material making up the collections. Apart from this, however, special investigations on a variety of subjects are from time to time undertaken by members of the staffs. The results are published in the "Annals" of the museums or as contributions to the journals, etc., of learned societies. Much of the usefulness of the museums consists in the stimulus and assistance which they afford to workers outside.

The Universities.

Till 1918, the Union of South Africa possessed only one university, the University of the Cape of Good Hope, which was purely an examining body. Education of a university standard was, however, being provided in eight colleges throughout the country. In 1918 the University of the Cape of Good Hope was dissolved and three teaching universities were established, viz., the University of South Africa, the University of Capetown, and the University of Stellenbosch. In 1922, the University of the Witwatersrand, Johannesburg, was added to the number.

The University of South Africa, which has its headquarters at Pretoria, is a federal institution and at present embraces six university colleges, viz.—

Grey University College, Bloemfontein;
Huguenot University College, Wellington;
Rhodes University College, Grahamstown;
Transvaal University College, Pretoria;
Natal University College, Pietermaritzburg; and
Potchefstroom University College.

From this it will be seen that the Union is amply provided with facilities for higher education.

The universities exhibit a certain degree of specialization; thus, for example, only at Capetown and Johannesburg are there faculties of

medicine; only at Stellenbosch and Pretoria, faculties of agriculture. Engineering is taught at Johannesburg, Capetown, and Durban; mining engineering at Johannesburg only.

During recent years there has been a marked improvement in the staffing, equipment, and accommodation of all the universities. For the Universities of Capetown and the Witwatersrand, large new buildings, in which every facility for both study and research is being provided, are at present in course of erection.

Research is fully recognized in the South African universities as one of their most important functions, and work of this character is being actively carried on by members of the staffs and by students, by whom many notable contributions to knowledge have been made.

Scientific Societies.

The Union possesses a large number of strong and active scientific and technical societies, most of them centred in Johannesburg. The latter circumstance is due principally to the large number of scientifically trained professional men employed by the mining industry of the Witwatersrand. Recently most of the scientific societies have become associated for the purpose of common action into a body known as "The Associated Scientific and Technical Societies of South Africa," with its headquarters in Johannesburg.

The following are the principal scientific societies of the Union:

(i) *The Royal Society of South Africa.*

This society was founded in 1877 as The South African Philosophical Society, with the comprehensive object of "promoting original research and recording its results, especially as connected with the natural history, physical conditions, history, geography, statistics, industrial resources, languages, and traditions of South Africa." Under Royal Charter of Incorporation, dated 25th June, 1908, the society was established in its present form with the designation of The Royal Society of South Africa. The results of the researches conducted by members of the society and others are presented in the form of papers read at its meetings and are published for general information in its Transactions.

(ii) *South African Association for the Advancement of Science.*

The South African Association for the Advancement of Science was founded in 1902, its objects being—

(*a*) to give a stronger impulse and a more systematic direction to scientific inquiry;

(*b*) to promote the intercourse of societies and individuals interested in science in different parts of South Africa;

(*c*) to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public character which may impede its progress.

At the annual session of the association, held in different centres, usually during July, papers are read and discussions invited in all branches of science, which are classified into appropriate groups, and dealt with by six sections.

The headquarters of the association are in Johannesburg.

The organ of the association is the *South African Journal of Science.* A medal, known as the South African Medal, and a grant of £50, are awarded annually by the Council of the Association for achievement and promise in scientific research in South Africa.

(iii) *The Chemical, Metallurgical, and Mining Society of South Africa.*

This Society was founded in March, 1914, as the Chemical and Metallurgical Society of South Africa, Mining being added in

February, 1903, and was incorporated in the Transvaal in May, 1907. It has taken an active share in the scientific organizations which have been formed in recent years for the purpose of serving the industrial advancement of the Union.

The objects of the society are—

(*a*) to advance technical and metallurgical chemistry and the science and practice of mining;

(*b*) to cultivate all branches of pure chemistry;

(*c*) to extend the knowledge and practical application of improvements and discoveries in matters bearing on the chemical, metallurgical, and mining professions, and to afford members opportunities for interchange of ideas on chemistry, metallurgy, and mining.

The society holds meetings at monthly intervals, and publishes a monthly Journal of Proceedings. Its headquarters are in Johannesburg.

(iv) *South African Institute of Electrical Engineers.*

The South African Institute of Electrical Engineers was formed in 1909.

The objects of the institute as embodied in its constitution are—

(*a*) to promote the general advance of electrical science and its applications; to facilitate the exchange of information and ideas on these subjects among all members of the institute; to place on record the results of experience elicited in the discussion thereon, and to do all such things as are incidental or conducive to those attainments;

(*b*) to hold meetings for reading and discussing communications, works, or treatises bearing on electrical science and its applications, or on subjects connected therewith;

(*c*) the formation of a technical library and modern laboratory for the purpose of promoting research in electrical science, to be open to all members of the institute.

The headquarters of the institute are at Johannesburg. Monthly meetings of members are held, at which papers are read and scientific questions of engineering interest are discussed.

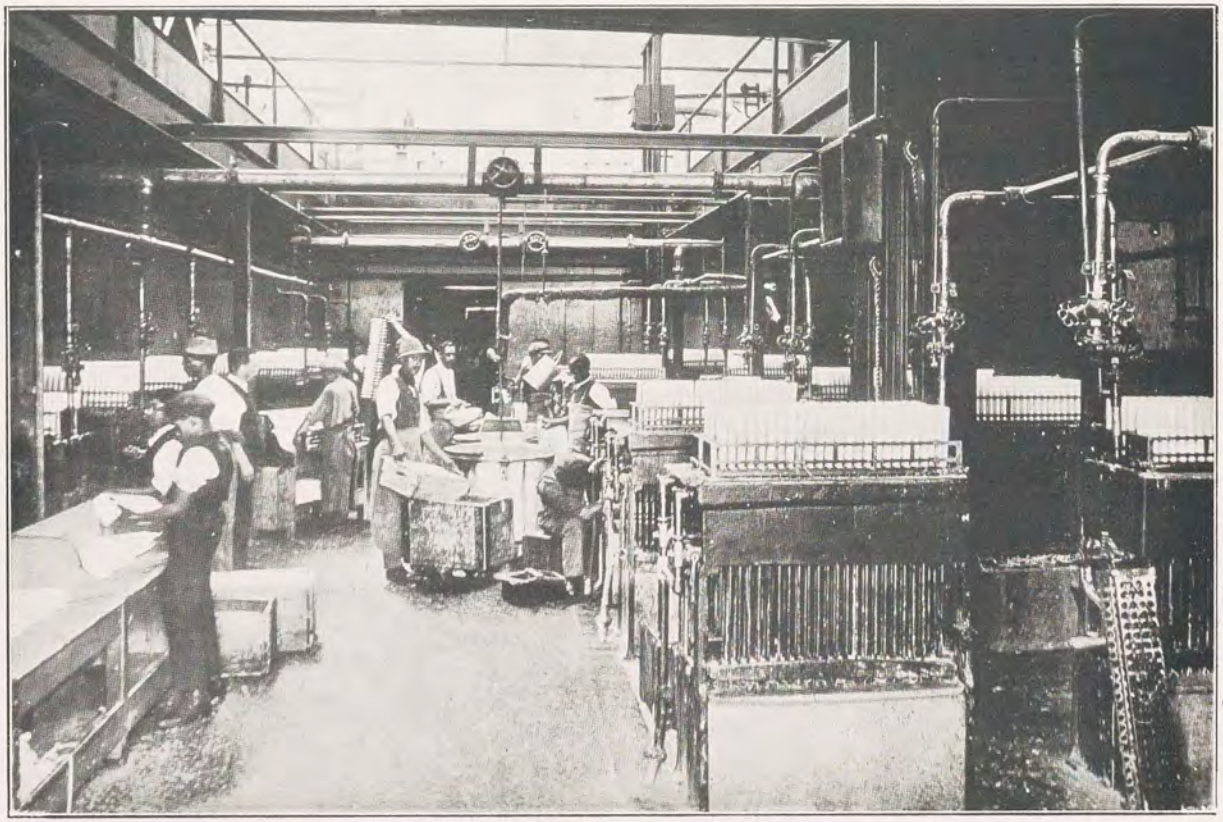
A monthly Journal is devoted to the interests of the Institute.

(v) *The South African Institution of Engineers (Incorporated).*

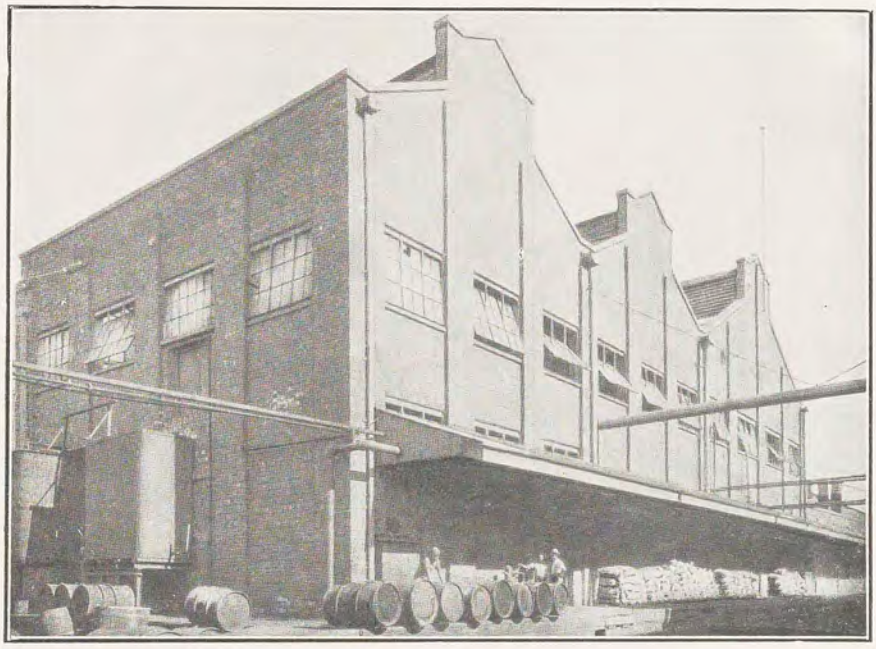
The South African Institution of Engineers (Incorporated in the Transvaal) owed its inception to the amalgamation, in October, 1910, of two associations, with kindred objects, which had been existence for over a decade. The Institution has as its general aim the advancement of the science and practice of engineering in all its branches, and its organization provides means for the acquisition and preservation of the continually increasing knowledge accumulated by engineers in the course of their experience in South Africa. The vehicle for the dissemination of this knowledge is the monthly Journal of the Institution, in which is published a record of the proceedings at the periodical meetings of the Institution, together with all papers read at these meetings. Besides acting as a medium for the publication of information on the subjects embraced in its sphere, the Institution seeks to stimulate the spirit of keener research by the offer of several annual prizes for papers and theses of conspicuous excellence. The headquarters of the Institution are situated in Johannesburg.

(vi) *South African Society of Civil Engineers.*

The South African Society of Civil Engineers was founded at Capetown in 1903 as the Cape Society of Civil Engineers. Its objects are the



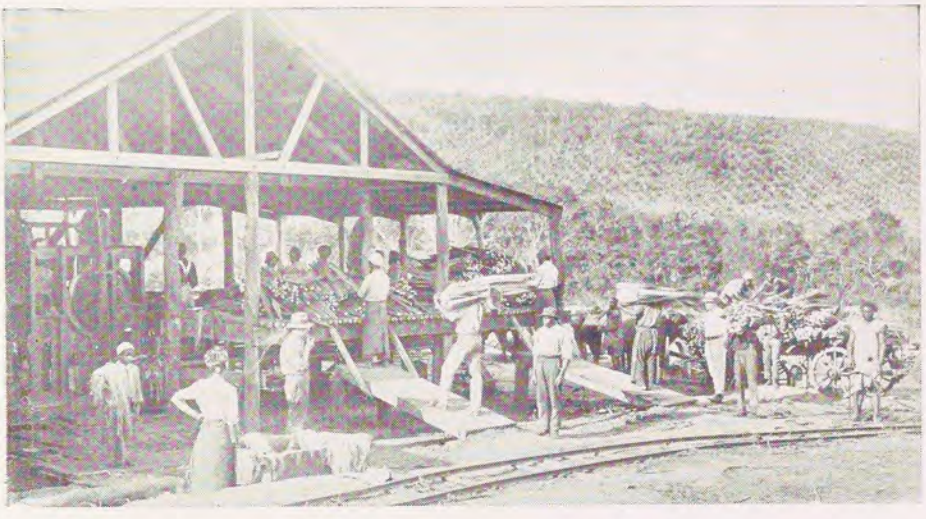
A Moulding Room in a South African Candle Factory.
[Messrs. Price's Works at Capetown.]



The Soapery at the Sunlight Works, Durban.

In a Cape Wine Cellar.

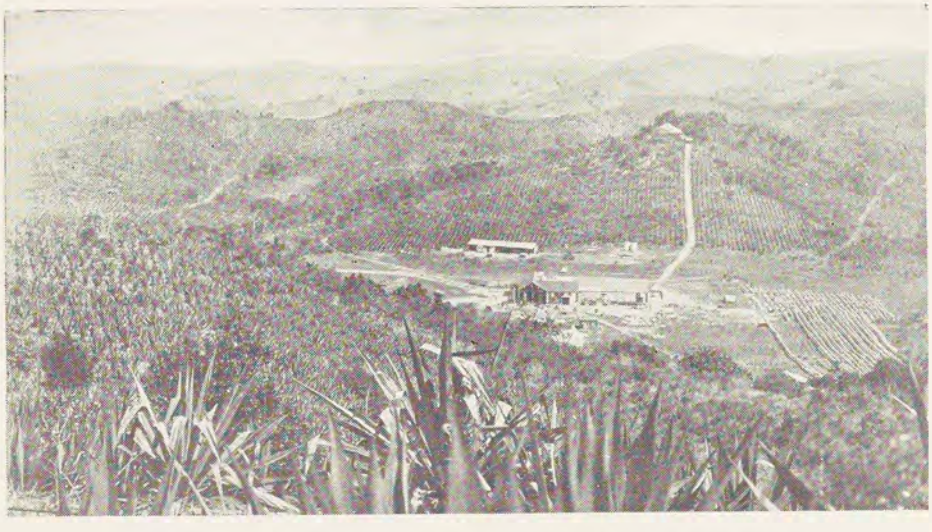
SCENES ON A NATAL FIBRE PLANTATION.



DECORTICATING SISAL AND FURCRAEA LEAVES.

FIBRE ON DRYING-LINES.

BUNDLES OF *Hibiscus cannabinus* GROWN AT DUIVEL'S KLOOF, NORTHERN TRANSVAAL.



A FURCRAEA PLANTATION AT HIBBERDENE, NATAL SOUTH COAST.

advancement of the science and practice of civil engineering and the maintenance of the status of the profession. In 1910 it assumed its present title. Periodical meetings are held at Capetown. Papers of South African interest, and dealing mainly with matters pertaining to the public utility services, are read and sent out to all members in printed monthly Proceedings.

(vii) *The Geological Society of South Africa.*

This society was founded in 1895, and it has for its object the promotion of geological research. The publications of the society, which consist to date of twenty-five volumes of Proceedings and Transactions, form a complete record of the progress which has been made in organized geological study in the Union during the past twenty-eight years. Of recent years the Transactions have served as the vehicle of publication for much of the work of the geological survey of the Union. Special interest centres in the valuable mineral collection made through the efforts of the society and now housed in the Geological Museum, Plein Street, Johannesburg. The headquarters of the society are in Johannesburg, and meetings are held normally once a month.

(viii) *Cape Chemical Society.*

This society was founded in 1905 with the object of promoting the study of pure and applied chemistry. Membership is restricted to persons in the Cape Province "qualified to engage in the profession of chemistry." Papers on chemical subjects are read from time to time at the society's meetings. The headquarters of the society are in Capetown.

(ix) *South African Chemical Institute.*

The South African Chemical Institute was founded in 1912 as the "South African Association of Analytical Chemists," and assumed its present title in 1921. It exists for the purpose of raising the professional status of those practising analytical chemistry and with the object of encouraging the study of that science.

The Institute publishes a Journal containing scientific contributions, which appears twice a year. The headquarters of the Institute are in Johannesburg.

(x) *Botanical Society of South Africa.*

The Botanical Society of South Africa came into existence on the 10th June, 1913, and was the outcome of a movement to stimulate interest in the preservation, cultivation, and study of the vegetation of South Africa. The objects of the society are—

(*a*) to encourage the inhabitants of South Africa to take an active part in the progress and development of the National Botanic Gardens at Kirstenbosch, a part of the Groote Schuur Estate, in the Cape Province, and to induce them to appreciate their responsibilities therein;

(*b*) to augment the Government grant towards developing, improving, and maintaining fully equipped botanical gardens, laboratories, experimental gardens, etc., at Kirstenbosch;

(*c*) to organize shows at which may be displayed the results of botanical experiments or cultural skill in improving the different varieties of South African flora;

(*d*) to enlighten and instruct the members on botanical subjects by means of meetings, lectures, and conferences, and by the distribution of literature.

An annual Journal is published. The headquarters of the society are in Capetown.

(xi) *The South African Biological Society.*

This society originated at the close of 1916 as the result of a movement to

unify existing organizations interested specifically in the study of zoological matters. The objects of the society are—

(*a*) to advance the study of biological science, and to give all possible assistance to those in South Africa who are interested in the study of natural history;
(*b*) to publish a journal of biology and natural history, together with the transactions of the society;
(*c*) to advocate the preservation of the monuments of nature;
(*d*) to hold scientific congresses from time to time in various centres.

The official organ of the society is "The South African Journal of Natural History." The headquarters of the society are in Pretoria.

(xii) *The South African Geographical Society.*

The society was founded at Johannesburg in June, 1917.

Its objects are—

To raise the standard and to safeguard the interests of geographical education, to encourage geographical research in all its branches, and to arouse in the general public some enthusiasm for a subject which has such a direct bearing on everyday life.

It publishes a Journal. The headquarters of the society are in Johannesburg.

(xiii) *British Medical Association (in South Africa).*

The registered office of the association is in London, England; and its branches in South Africa are—

(1) The Western Province Branch (Cape of Good Hope): Headquarters, Capetown.
(2) The Eastern Province Branch (Cape of Good Hope): Headquarters, Grahamstown.
(3) The Griqualand West Branch (Cape of Good Hope): Headquarters, Kimberley.
(4) The Border Branch (Cape of Good Hope): Headquarters, East London.
(5) The Natal Coastal Branch: Headquarters, Durban.
(6) The Natal Inland Branch: Headquarters, Pietermaritzburg.
(7) The Orange Free State and Basutoland Branch: Headquarters, Bloemfontein.
(8) The Witwatersrand Branch (Transvaal): Headquarters, Johannesburg.
(9) The Pretoria Branch (Transvaal): Headquarters, Pretoria.
(10) The Rhodesian Branch (Southern Rhodesia): Headquarters, Bulawayo.

The objects of the association are *inter alia*:—

(1) To promote the medical and allied sciences and to maintain the honour and interests of the medical profession.
(2) To hold or arrange for the holding of periodical meetings of the members of the association and of the medical profession generally.
(3) To circulate such information as may be thought desirable by means of a periodical journal, which shall be the journal of the association, and by the occasional publication of transactions or other papers.
(4) To grant sums of money out of the funds of the association for the promotion of the medical and allied sciences in such manner as may from time to time be determined on.

The overseas branches of the association possess almost complete autonomy, managing their own affairs, with one notable proviso that they do not embark on any project which if it were an object of the association would make it a trade union.

Since the year 1912, the association has also been represented in South

Africa by the South African committee on which each branch is represented according to its membership.

The South African committee meets quarterly at various centres in rotation, for the transaction of its business, which is chiefly of a professional and a medico-political character. It is also the executive committee of the South African medical congresses.

These congresses are held annually under the auspices of the British Medical Association in South Africa and are conducted on lines similar to those of the annual meeting of the association in Great Britain, except in that all medical practitioners in South Africa, whether belonging to the British Medical Association or not, are invited to become members of congress.

Anthropological Research.

The first descriptions we have of the native races of Southern Africa are to be found in the writings of the early travellers to these shores, after the settlement of the Dutch at the Cape in 1685. These writings are in Dutch, German, French, and English, and are too numerous to mention individually. Probably the most exhaustive description of a native people and its customs is that of *Peter Kolben "Caput Bonae Spei Hodiernum,"* Nürnberg, 1719.

In addition to these early writings the records of the Dutch East India Company, especially the Journals of the officials sent out on exploring expeditions, contain valuable information which has never been thoroughly sifted from an anthropological point of view, though it has formed the basis of the work of Theal in his *History and Ethnography of South Africa.*

After the travellers and explorers, none of whom were mainly interested in the study of the natives, came the missionaries. By these men a great deal of work has been done in linguistics, and grammars and dictionaries have been published in most of the languages spoken in Southern Africa. The only complete monograph we have of a native tribe, so far, is that of Junod on the Baronga (*The Life of a South African Tribe*), but the works of Livingstone, Moffat, Casalis, Jacottet, Callaway, to mention only a few of the missionary writers, are full of valuable material. Another source of information is to be found in Government Blue-books and Reports, under the auspices of the Cape Government.

Sir George Grey, in the fifties of last century, investigated the folk-lore and customs of the native peoples, and Dr. Bleek, the eminent German philologist, was given every encouragement and assistance by Sir George Grey, and it is largely owing to his work that we have records of the Bushmen languages, and some knowledge of the various Hottentot dialects of the Cape Province. Dr. Bleek's work was continued by Miss Lloyd and is now being followed up by Miss Bleek. It is hoped that Dr. Bleek's very complete dictionary of the Cape Bushman dialects will be published at an early date. The *Folk-lore Journal* was started in 1879, but continued for only about ten years.

Anthropometry and archaeology are almost untouched fields in Africa. In 1872 Gustav Fritsch published his work on *Die Eingeborenen Sud-Afrikas*, with measurements of a certain number of Bushmen, Hottentots, and members of various Bantu tribes. Since then, there have been reports of odd skeletons and measurements of a few specimens of various tribes in different scientific periodicals, but the only systematic comparative work, so far, has been done by F. O. Shrubsall with material supplied to him by the various museums in South Africa, together with that in the Museum of the Royal College of Surgeons. His results have been published in the *Journal of the Royal Anthropological Institute*, the *Annals of the South African Museum*, and in the journal *Man*. Study of the stone implements of South Africa and of their makers is also in its infancy, but has received a

great impetus lately. The late Dr. Peringuey made valuable collections of these implements and reported on them in the *Annals of the South African Museum* from time to time, while J. P. Johnson collected and studied the implements of the northern parts of the country, chiefly in the Transvaal. Discoveries have been made by Dr. Peringuey and Mr. Fitz-Simons, Director of the Port Elizabeth Museum, of what appear to be very ancient skulls of a kind totally different from those of the Bushmen or Strandloopers.

G. W. Stow collected information concerning the Koranna and Griqua peoples and the various Bushman peoples of South Africa. His book on *The Native Races of South Africa* was edited by Theal and was published in 1905. It is one of our chief sources of knowledge of the later movements of the Bushmen and Hottentots. A book on *The Bushmen of the Kalahari* by the Rev. Dornan has been published.

Within the last few years many developments have taken place which promise a new era in the history of Anthropology in South Africa. In 1920, a School of African Life and Languages was established in the University of Capetown, where the first piece of comparative research work on the intelligence of European and Xosa children has recently been carried out.

In the Transvaal, great progress is also being made. Here, two years ago "Bantu Studies," the first periodical of a scientific nature since the *Folk-lore Journal* ceased publication, was started. Further, at the beginning of this year a Department of Bantu studies was instituted in the University of the Witwatersrand, where both philology and phonetics, as well as Bantu ethnology, are being taught.

The new medical schools, too, are interested in the native races, and trained anthropometrists are beginning investigations on the skeletal remains as well as on the living specimens of various races. The Government has further authorized funds for the publication of monographs on native peoples, and is offering special inducements to its officers to take up the study of anthropology seriously.

Historical Research.

Historical research in South Africa is still largely at the initial stage of collecting and preserving and indexing the records, and is only beginning to make the rich materials readily accessible to students. Books of local interest are in keen demand as "Africana." The *Bibliography* of the Mendelssohn Collection, now housed in the Parliamentary Library, Capetown, was published in London, 1910, and is a valuable but by no means complete guide to the printed materials of South African History. Other important collections of historical books, pamphlets, and papers are those in the South African Public Library, Capetown, and in the Public Libraries at Port Elizabeth and Durban, and one notable private collection is that of Major W. Jardine, Capetown.

Of unpublished historical sources the Union and Provincial archives are, of course, the most important. These include the Cape Records, much the largest collection, dating back to the beginning of things in 1652, together with those of Natal and of the two Republics. Though still housed in their respective capitals, these are now all vested in the care of an Archives Commission.

These South African collections do not however exhaust the official sources, and much more is contained in the Records of the Colonial Office and other departments, housed in the Public Records Office, London, or for the eighteenth century, at the Hague. Of all this material very little is available in print. Mr. H. G. V. Leibbrandt, Keeper of the Cape Archives, made a *Précis* of specimens of the Records of the Dutch East India Company, and his successor, Dr.

Theal, greatest of pioneers of South African historical study, was enabled to publish, besides other fragments, thirty-five volumes of the *Records of Cape Colony*, 1795-1827. The present Union Archivist has published a *Guide to Documents in the Cape Archives* (Capetown, 1918). The Van Riebeek Society has for aim the publication of South African Historical Documents and has four volumes to its credit, including the important *Memorandum on the Cape* by the Batavian Commissioner, De Mist.

Besides the official records there are, of course, unknown masses of MSS. material in private hands. For the early nineteenth century in particular, and for all-important questions of the relations of black and white, the records of the missionary societies are of high value. Those of the London Missionary Society, London, certainly contain much that deserves study. The Records of the Church Missionary Society have lately been drawn upon for the study of events in the early days of Natal, and the Wesleyan, Paris, and other Societies must have much material that has hardly been touched. Much of the correspondence also of governors and public men like the D'Urban letters, of which the South African Library has copies, is likely still to come to light.

As to achievements, Dr. Theal's remains the principal general history, with the volumes by Sir George Cory for the rise of the Eastern Province. Native questions and ethnography receive increasing attention, but G. W. Stow's *Native Races of South Africa*, and Theal's ethnography have not been superseded. For native, as for social and economic problems, not only raw material, but the results of solid study are often half-buried in British or South African Parliamentary Papers and Government Blue-books.

The field for research is wide and interesting, but the disabilities of historical and social study are great. The material, as indicated, is scattered over South Africa, Great Britain, and Holland. The indexing either of the Archives or of Government publications like blue-books, is either deficient or quite untouched.

Magnetic Observations in South Africa.

Investigations of the magnetic conditions prevailing over the surface of the earth are of great practical importance, chiefly in the interests of navigation. Hence in all civilized countries in addition to trigonometrical, geological, botanical, and other surveys, magnetic surveys are undertaken. Such surveys are required for the construction of magnetic charts for the guidance of ships at sea.

The condition of the earth's magnetism at any point is specified by means of three elements:—(i) The declination or variation of the direction of the compass needle from true north, (ii) the dip of a truly balanced magnetic needle from the horizontal, and (iii) the intensity of the magnetic force at that point. The magnetic survey of a country consists in the determination of these three elements at a series of selected points over the country so that charts may be drawn showing the progressive change of the magnetic elements across the country. Unfortunately, the earth's magnetic state is not constant but changes with time. Hence a magnetic survey is only strictly correct for the epoch at which it was made. It, therefore, becomes necessary to repeat the determination of the magnetic elements at a few points in the country in order to find the rate at which they are changing. When the values of the secular change of the elements have been well determined, charts may be constructed for epochs other than that at which the survey was made.

Until comparatively recent times there existed no magnetic survey of South Africa. Magnetic observations had been confined chiefly to Capetown and its neighbourhood. The earliest observation recorded was made at

Mossel Bay in 1595. At this time the declination was zero, i.e. magnetic North coincided with true north. From that date the magnetic needle gradually turned westwards until 1873, when the declination became 30° west of true north. From 1873 the declination has been decreasing at the rate of about one degree in five years.

The first systematic magnetic survey of South Africa began in 1898 and was carried out by Professor (now Sir Carruthers) Beattie and Professor Morrison. The survey was made with the aid of grants from the Royal Society, the British Association, and the Governments of Cape Colony, the Transvaal, the Orange River Colony, Natal, and Rhodesia. As the result of this work, charts showing the distribution of the three magnetic elements over South Africa for the epoch 1st July, 1903, were constructed. With the assistance of grants from the Union Government, the Royal Society of South Africa, and the Rhodesian Government a more recent series of observations has been made with a view to the more accurate determination of the secular changes of the magnetic elements and magnetic charts for the epoch 1st July, 1913, have been published.

A complete account of the magnetic work done in South Africa is to be found in the "Report of a Magnetic Survey of South Africa," by J. C. Beattie, published by the Royal Society (of England) in 1909, and in various papers in the Transactions of the Royal Society of South Africa.

CHAPTER X.

THE FISH AND FISHERIES OF SOUTH AFRICA.*

TO understand the present state and the possible future of the fishing industry in South Africa it will be well to keep in view its historical development. Like most other industries, its progress has been bound up with the history of the country in which it has appeared, and, owing to the somewhat unique history of South Africa, the development of the industry has not been on quite the usual lines. The progress of an industry is also connected with the physical features of the country; the "Cape of Storms" is not the best environment for the beginnings of a prosperous fishing industry. It is true that this region in the early days of the East India Trade very soon acquired a great reputation for the abundance of fish in its seas, and a curious, and at the same time convenient, superstition arose among seafaring men that it was not lucky to pass the Cape on the long journey to the East without a short delay for the purpose of fishing on the Agulhas Bank. Some of the older captains of sailing ships have still wonderful stories to relate as to the great abundance of fish they found when, on passing the stormy Cape, they stood in towards the quieter waters near Cape Agulhas. Though fish were undoubtedly there, and could be caught in large numbers, the justification for any delay of the ship was not probably sufficiently strong in the eyes of her owners without an appeal to seamen's superstition.

Van Riebeeck's Policy.

If the Cape seas were as prolific as their reputation seemed to indicate, why, it may be asked, did no great fishing industry develop, or even show any signs of development from the time when the early settlers took up their abode on the shores of Table Bay? The reason is not difficult to discover, as it is recorded in the early history of the Cape, more especially in the interesting pages of Van Riebeeck's Journal. Here we very soon learn that the policy of Van Riebeeck was, not to develop the Cape, but to utilize its resources to increase the wealth of the home country. The early settlers had little say in the matter, and they were enjoined to make every endeavour to increase their agricultural produce, and to trade with the natives, for the purpose of export and procuring provisions for the passing ships. These were not the days of refrigerators, skilled canning and curing processes, and there was no need for the encouragement of a fishing industry. Dutchmen are, however, born fishermen, and, whether for sport or the procuring of fresh fish, some were apparently inclined to turn their attention to fishing, for an official order was issued that they were not to "waste their time fishing." This was the official attitude towards the industry at that time, and it continued to be so for many years to follow; indeed, one seems to find a faint echo of the old order even in recent times and under conditions entirely altered.

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* By J. D. F. Gilchrist, M.A., D.Sc.

It is instructive to look back on some few incidental remarks on fish in the early records. Even Van Riebeeck was interested enough in fish to mention in his journal that, in an expedition to Saldanha Bay, a fish very like the well-known pike of his native country had been caught. The pike—known as the "snoek" in Holland—is a freshwater fish, and as this fish was found in the sea he calls it a "sea-pike" or "zee-snoek." It is mentioned casually, without enthusiasm, and certainly with no suspicion as to the value of the discovery. Had he known that this fish at certain seasons can be procured in enormous quantities, and is very suitable for preserving by the simple process of salting, perhaps he would have given it a second thought. The name "snoek" given by Van Riebeeck is familiar to all South Africans, though its origin has been lost sight of, and salted snoek not only constitutes an important article of food in this country, but is exported in large quantities, to the value of about £10,000 per annum.

In the same way it is mentioned incidently that a number of "fine large crayfish" were on one occasion brought by some Hottentots as a present for the Governor, with no suspicion that one day nearly a dozen canning factories in South Africa would be exporting these crayfish to Europe in millions to the value of over £200,000 per annum.

Though fishing was not encouraged, it could not be entirely suppressed, and we read of netting for harders in the Salt River, which apparently in those days was larger than it is now. Finally, certain freed Malay slaves were allowed to take up fishing as a permanent occupation.

Trend of the Industry.

It was in this way that the general trend of the fishing industry was determined; it became more and more identified with the coloured population, while the attention of the European settlers was directed to agriculture. Thus it was that the sea-loving Dutchmen became the farmers and their Malay servants the fishermen of South Africa.

The Malay is, according to his lights, an expert fisherman. His small open boat and hand-lines he can use with skill, and he discovered that snoek could be caught in great numbers by the simple device of an unbarbed hook, baited with a piece of coloured rag. He found also that crayfish could be procured in any quantity by a simple dip-net. So that in those days the fish supply was more than abundant and cheap enough; with a large snoek or crayfish, to be purchased at the cost of one penny each, there could be no fear of starvation even for the poorest in the land.

It was found also that the fish, the "harder" or "mullet," was to be found in Table Bay and Saldanha Bay in large numbers. The Dutch settlers were well aware of the value of this fish, and how it was captured and preserved in Holland. Van Riebeeck's Company even went so far as to import from Holland the special nets necessary for its capture. These "trek" nets were used under the supervision of Europeans, and, by their means, large quantities of this fish were procured. The fish was of special importance to the farmer, as it could readily be salted and used as food for farm servants. It is still an important industry on the West Coast, and there is always a good demand for this fish in the country districts.

A demand for salted snoek also arose in the country districts, and in later years it was found that the surplus supply could readily be disposed of to the fish-eating Indian population of Mauritius. Even with this export there was enough and to spare for South Africa's requirements.

This stage in the development of the fishing industry lasted for a great number of years. There was a natural increase of population. The pioneers

of the country opened up new fields for agricultural enterprise and new coastal towns appeared. These became fishing centres, so that the fishing industry easily supplied all the demands made on it, more especially as the increase of the inland population in regions far removed from the sea did not affect the demand. There is no evidence of any great advance or even attempt at improvement in the industry in this country, though in other countries at this time the fisheries were making rapid progress, aided by new and improved fishing boats and methods of fishing. The Malay fisherman with his primitive boats and lines could easily supply the limited demand for fish.

A Sudden Change.

The change came somewhat suddenly, and was connected with the altered conditions which the discovery of the mineral wealth of South Africa brought about. The influx of additional population, and of capital for the development of industries, the rise of great inland towns, and the accessibility to all parts of the country by railroad, all made unexpected demands on the natural resources of South Africa.

The fishing industry was one of the least prepared to meet these demands, and, to add to the difficulty of increasing the supply, it was found that fish were becoming scarcer. The mainstay of the industry at that time—the snoek supply—had almost entirely failed, the fish, for some unknown reason, having practically disappeared. This was not confined only to this particular species of fish, but harders, silverfish, and other kinds were said to be much less abundant. Various reasons were suggested as to the cause of this, and inquiries into a possible remedy were instituted. The Government was appealed to for aid, and as it was suspected that the undue destruction of young fish in fishing operations might be the cause, the cure was sought in legislative measures, whereby the destruction of young fish and the spawn might be checked. The first measure adopted was the restriction of netting operations in some of the estuarine rivers, and subsequently an Act was passed forbidding the capture of snoek under a certain size.

This had no appreciable effect, and it was then thought that the introduction of new methods, and the opening up of new fishing grounds, might meet the difficulty and afford the promoters an adequate return for the capital invested. Several such private enterprises were undertaken. One was the introduction of experienced fishermen from the North Sea, and the other the fitting up of a large vessel manned with Norwegian fishermen, to develop the deep-sea areas off the Cape Coast, which were known to abound in fish. It was found, however, that the North Sea fishermen could not compete with the native fishermen, and they speedily found more remunerative employment. The expense involved in exploratory work undertaken by the second enterprise proved serious, and, there being no prospect of immediate, or indeed any practical results, this was soon abandoned.

Introduction of Steam-trawling.

The failure of these projects was, in a large measure, due to the fact that the methods of fishing—long-line and net-fishing, so successful in European waters—proved unsuitable for the Cape seas. The Cape fish as well as the Cape seas are very dissimilar to those of the Northern Hemisphere. Experiments were made with another method of fishing, viz., steam-trawling, which has proved to be one of the most successful modes of fishing, provided suitable conditions are found. These were carried out in Table Bay, Mossel Bay, and Algoa Bay by the owners of small steam vessels. In Table Bay only a small patch behind the breakwater was found suitable for trawling; at Mossel Bay the ground was found to be suitable for trawling, but few fish were procured; and at Port Elizabeth

a small area was discovered, which proved somewhat more promising, but of no great extent. Trawling in Table Bay was after a time abandoned; at Mossel Bay it was not continued; at Algoa Bay, however, it was carried on intermittently by steam tugs in their spare time, chiefly on account of the high price obtained for soles, which being a rarity in South Africa, fetched very high prices—up to 8s. a pair.

Another fishing venture about this time, but of a different nature, may be mentioned. In America there is a good demand for mackerel, a fish which is little appreciated at the Cape, and an enterprising American Company sent out a schooner provided with a large and very effective "purse" net for the special purpose of procuring this fish. Very large quantities were caught and salted for the American market. Representations were, however, made by the native fishermen to the Cape Government that this method of fishing was very destructive, and a law was passed forbidding the use of the net. The law was repealed soon afterwards, but, by this time the American schooner had left the Cape and, although further experiments were made by local fishermen with this net, no great success was attained, and they were finally abandoned. Though a large quantity of salted mackerel was procured by the schooner and put on the American market, it was ascertained, through the courtesy of the United States Fish Commission, that the venture had not proved a profitable one, the prices obtained being only sufficient to pay expenses.

Meanwhile the demand for fish was increasing, and fish were becoming scarce on the old inshore fishing grounds, owing, it was alleged, to the destruction of the spawn and immature forms of fish. Further legislation was enacted, but seemed to have no material effect.

Scientific Surveys.

It was in these circumstances that public attention began to be drawn to the state of the industry, and strong representations were made to the Government that something more than legislative measures was necessary. As a result of this, a Commission of Inquiry into the fishing industry was appointed by the Cape Government in the year 1894. This Commission recommended that active steps be taken towards a thorough survey of the fishing resources of the Cape seas, and that scientific investigation be made into the habits, more especially the much disputed question of the spawning habits, of Cape fishes, along the lines followed in other countries. The question of the alleged diminution of the fish supply should also receive attention.

The recommendation of the Commission was accepted by Government, and an officer, with the necessary qualifications, was appointed to advise and to carry out the necessary steps to be taken. He recommended that a survey of the South African seas by a steam vessel, adequately equipped for the purpose, should be undertaken in the first place. This was endorsed by a small Fisheries Committee, which was subsequently appointed to assist, and ample funds were placed at their disposal by the Government. It was decided that the officer appointed should proceed to England for the purpose of designing and purchasing a vessel suitable for the work. The type selected was similar to one then contemplated for the use of the Fishing Board of Scotland—a modern steam trawler. Special features, however, were that, while primarily of the trawler type, it could be used for line or net fishing, and was provided with a well in which fish could be brought alive to the market. The total cost of the "Pieter Faure," as the vessel was named, and equipment was about £8,000.

In accordance with the recommendation of the Commission, provision was also made for the necessary scientific

work in connexion with the fishery investigations, and a marine laboratory was subsequently started on a small scale with this object in view.

Search for Trawling Grounds.

As it seemed that the quickest and best results would be attained by trawling, the first efforts were directed to the discovery of trawling ground, though previous experiments by private enterprise had not proved encouraging. A commencement was made in Table Bay, and operations were subsequently extended to the West Coast as far as St. Helena Bay. The results were not promising. No extensive trawling ground was found near Table Bay, and, northwards towards Dassen Island, where a fairly large trawlable area was found, the net came up full of dogfish, with only a few edible fish, chiefly stockfish. Further towards the north, good ground was again found near St. Helena Bay, and some extraordinary large soles, up to 12 lb. in weight each, were found, together with a fair number of stockfish and king-klip fish. In those days there was no means of conveying fish in a fresh condition to the market from long distances, and this promising area was, therefore, not further investigated, attention being turned to possible fishing ground nearer Capetown. That this discovery, however, proved to be of value in later years, is well known in Capetown, where stockfish, king-klip fish, and the large sole, now known as the "supersole," are landed in quantities by trawlers.

False Bay seemed to be the most promising locality near Capetown for further investigation. It was not entirely unknown as regards trawling possibilities; there are traditions that some enterprising men had already trawled in a small steamer along the Muizenberg Beach, and before the Fisheries Committee had finally decided to recommend the purchase of a properly equipped vessel, it was thought that a preliminary experiment might be made in False Bay. A small paddle-boat, the "John Paterson," manned by a miscellaneous crew, and equipped with an old trawl net, was therefore hired for the purpose. The first haul was made along the shores from Simonstown to Kalk Bay, and the net came up full of redbait. A little consolation was found in the fact that the bag contained two soles. The trawl net was then put over and dragged parallel to the sandy shore of Muizenberg Beach. The net seemed to be going very well over this sandy bottom, and a long drag was made in the hopes of procuring a good bag of soles, which were known to occur on this ground. This time, however, the net did not come up at all—except a few fragments attached to the beam. The results were of no value except to prove that proper equipment was necessary.

It was, therefore, with some interest that the investigations were renewed here with the "Pieter Faure." The first hauls were made this time from a few miles off Simonstown, out towards the centre of False Bay, and proved very promising. Large hauls of edible fish were procured, as many as 6,000 in an hour's drag, and further investigation of this area was continued. An unexpected difficulty, however arose. Up to this time the native fishermen had viewed with complacency and some amusement the efforts of the trawler—one indeed undertook to eat all the fish that it caught—but it now appeared that the results were to be taken more seriously. They were still experiencing a scarcity of fish, and they now alleged that this was due to the operations of the "Pieter Faure," which, they stated, not only took the fish from their fishing ground, but dragged up and destroyed the spawn of the fish deposited on the sea bottom. A deputation of fishermen made strong representations on this point to Government, and a Select Committee of the House was appointed to inquire into their grievances.

Fortunately, by this time some information on the spawning of Cape fish had been obtained in the course of the work carried on at the Marine Laboratory at St. James. It was ascertained that the eggs and larvae of most of the common fish caught in False Bay—silverfish, panga, stockfish, etc.—were small and floated near the surface of the sea. This information was laid before the committee, together with an account of the work of the survey, and they came to the conclusion that the evidence of destruction of the eggs and young of fish was not sufficiently strong to condemn trawling. They recommended that the survey should be energetically continued, but that, if possible, new fishing grounds be discovered.

The next area, therefore, to which attention was turned was a portion of the Agulhas Bank, off Mossel Bay, beyond the limits of the area visited by the few small fishing boats at that locality, and over a hundred miles from the nearest large fishing centre.

Discovery of Rich Ground.

Here, for the first time, success was assured. Even in False Bay the good ground was patchy, and the limited number of soles procured were "sand-soles," and of no great value. Here very extensive areas were found with a clear bottom, and, not only with a good supply of the ordinary fish, but large quantities of the valuable mud-sole. The problem, however, then presented itself as to how this supply of fish could be brought to the market. There was no demand at the nearest port, Mossel Bay, which in those days had no railway connexion with the larger towns. Some of the fish was sold at Mossel Bay and Oudtshoorn, but the prices obtained soon fell to such an extent—½d. per lb. for soles—that this afforded no solution of the difficulty. Various devices were tried, such as storing the fish in a temporary ice-house, and sending them to Capetown by the mail boats which called at Mossel Bay. Finally it was found that the fish could best be brought to Capetown in ice by the survey boat itself. They were at first sold by auction on the Parade in Capetown, and later to local fish merchants, and it was shown that this could be done at a profit. The soles, which were procured in large numbers, proved to be the most profitable, and there was a great demand for these fish, which, for the first time, could be obtained in quantity and at a reasonable price by the public.

There remained then the question as to the utilization of these results. No difficulty was experienced in finding private enterprises to follow up the work; in fact, some of these were entered into so rashly that disastrous results were inevitable. Shortly after the discovery became known, a small steamer with a trawl net appeared on the new fishing ground from Natal, but after a few trips apparently found the distance too far to make it a payable proposition, though to-day it is possible to land fish in Durban from these fishing grounds.

Beginning of the Trawling Industry.

The first firm to make a practical success was one then carrying on a small fish-curing and canning business at Hawston, near Hermanus. They were persuaded to transfer their business to Mossel Bay, the possibilities of which they were very ready to perceive. The Government undertook to supply the fish for a start, and very soon afterwards they had an opportunity of acquiring a well-equipped steam trawler of their own.

The history of this steam trawler is of interest, as it is associated with one of the enterprises referred to as somewhat disastrous. It was initiated by an energetic and enthusiastic sea-captain, who was not only familiar with the early traditions of the abundance of fish on the Agulhas

Bank, but who had personal experience of certain localities, where he himself had caught them in incredible quantities. His experience was apparently confirmed by the results of the Government survey, and he had no difficulty in raising funds in Capetown for the purchase and equipment of a fine steam vessel, fitted out with special refrigerating appliances. Believing that certain areas near Cape Agulhas were even better fishing grounds than those found by the "Pieter Faure," trawling operations were commenced there, against the advice of the officers of the Government trawler. Finding that the trawl nets were torn up on the rough bottom, he conceived the original idea of trawling in mid-water. By this device the nets were saved, but no fish were caught. After persistent but fruitless efforts in this direction the "Pieter Faure" grounds were visited, and a large haul of fish was procured and stowed away in the refrigerating chamber on board. Owing to some defect, however, in the refrigerating apparatus, the fish were found to be in a decaying condition on arrival at Capetown. In view of these disappointing results the Company considered it prudent to bring their activities to a somewhat abrupt end, and dispose of the steam trawler. Doubtless, had they persevered, things would have come right, for, at a later date, other vessels, fitted with refrigerating apparatus, proved quite suitable for the work, and trawling operations were carried on successfully, working from Capetown as a centre.

This brings us to the development of the trawling industry at Capetown. The Government reports on the work of the "Pieter Faure" attracted the attention of one of the largest trawling companies operating in the North Sea, Messrs. Irvin, and they promptly sent out to South Africa some of their most powerful modern trawlers. This was, of course, a serious venture, and many foreseen and unforeseen difficulties were encountered. It was backed, however, by sufficient capital and experience of the business, and ultimately a promising commencement was made.

About this time another company of local origin was started for the exploitation of the new trawling grounds. It was not a success, chiefly on account of the initial error of purchasing a trawler not suitable for the work. This was providentially wrecked and the operations of the company brought to a speedy close.

Investigations in Natal Waters.

Meanwhile, the attention of the Natal Government had been directed to the results of the survey, and they approached the Cape Government for a loan of the "Pieter Faure" for a short period, in order to ascertain the fishery potentialities of the Natal waters. This was agreed to, and a survey was carried out, somewhat hurriedly in order to cover as much ground as possible in the time—three months—allowed for the work. A fairly large area off the Tugela River was found, in which trawling was practicable, but, though a great variety of fish, including soles, were procured, they were mostly of a small size, and not in sufficient quantity to justify any prospect of commercial trawling. The experiment was, however, by no means conclusive, as the time allotted for the survey was far too limited. It has been repeatedly shown that such hurried surveys are of little value. Here also, as at the Cape, there had previously been several trawling experiments carried out by private enterprise, and with the same unsatisfactory results.

The work of the "Pieter Faure" in Cape waters was then resumed, and extended to the East Coast, where two somewhat limited but rich fishing areas were found, one near Bird Islands and another near East London.

In the year 1905 a time of serious depression set in, and, as the results attained seemed sufficient for the time, the Government suspended the survey, leaving the exploitation of the new fishing ground to private enterprise.

The fishing industry was not, however, entirely neglected by Government, and during its considerable development in the next decade a great deal of useful and necessary assistance and supervision was rendered. After Union the fisheries were delegated to the care of the two maritime Provinces of the Cape and Natal. The Cape fishery organization consisted of an advisory board together with a fishery officer and fishery adviser; in Natal there was an advisory board and fishery officer. In both Provinces a considerable amount of necessary legislation and supervision was undertaken for the protection and development of the industry, and, at the Cape, investigations into the spawning and other habits of fish were carried on at the Marine Laboratory in so far as funds permitted. These were published in Marine Biological Reports, Vols. I-IV, by the Cape Administration. The Cape Fishery Board issues no reports, but the Natal Fishery Board issues an annual report, in which the collection of fishing statistics is an interesting feature, an important part of fishery work, which the Cape Provinces had not carried on, owing to insufficient funds.

For the same reason certain other proposals of the Cape Fishery Administration had to be abandoned, such as the more adequate supervision of the industry by fishery officers, a promising scheme for the introduction of the European herring, the establishment of crayfish hatcheries, etc.

Progress of the Fishing Industry.

Turning now to the development of the fishing industry during those years, we have to note progress in various directions. About thirty years ago a few Sicilian fishermen had taken to fishing in Table Bay. Their methods were somewhat different from those of the Cape fishermen, and resembled the American venture, already noted, in that nets were used in the open sea, which could not be reached by the "trek" nets of the Cape. Instead of the purse-net, however, they used the set-net and the tuck-net. Their early efforts were unobtrusive and did not attract much attention. These few early Italian fishermen, however, were soon followed by others, who had learned of the success of their countrymen, and the more congenial surroundings of the Cape. The Sicilian fishermen are also farmers, and the failure of the vine crops, and other precarious conditions of life in their native land, induced them to turn their attention to South Africa. The little colony of Italian fishermen increased in numbers; they built better boats, decked or half-decked, and suitable for proceeding considerable distances and remaining at sea for several days. They thus became serious competitors with the native fishermen, who used only the small open boat, which they dragged up on the beach after the day's work. Disputes arose as to the effect on the industry of these new methods and the Fishery Department was called on to make various investigations into the alleged destruction of small fish, the diversion of fish, such as the geelbek from their usual courses, etc. Various regulations were framed to meet these, where it seemed desirable.

Another important aspect of the work of the Cape Fishery Department was the endeavour to improve the harbour accommodation for fishermen. The South African coast is deficient in natural harbours, and this, combined with the stormy nature of seas, was a great drawback to the progress of the industry. Various improvements were carried out at Hawston, Hermanus, and other places, when

funds permitted. A more important undertaking was the construction of a fishing harbour at Kalk Bay and of a new fishing harbour at Capetown. The former has now been completed for some few years, and the effects are becoming apparent. Kalk Bay was a typical fishing centre, the fishermen of which are mostly descended from ancestors originally from Manila. Their origin is still evidenced by some traces of their knowledge of Spanish and their religion. Though of different origin their methods of fishing were and still are identical with those of the Capetown Malays. Their open oar-propelled boats were drawn up on the beach after each fishing trip, but a remarkable transformation followed better harbour accommodation. Their boats are now being converted, as far as possible, into decked motor-propelled vessels, and new and large boats are being built.

At Capetown, also, the aspect of the native fishing industry has changed. The old insanitary and crowded fishing market has disappeared, and Rogge Bay, a familiar scene of picturesque confusion of fish and fish refuse and Malays, struggling under the burden of their heavy boats, will shortly be a thing of the past. As has been the case of Kalk Bay, the improved harbour accommodation will doubtless be followed by larger boats, fitted with motor-power.

While these developments have been appearing in the old-established inshore fishing industry, there have been advances in the deep-sea fisheries and exploitation of the new areas further afield, rendered possible by the progress of steam-trawling. The chief advance in this direction has been at Capetown and Mossel Bay, though at Port Elizabeth and East London there has also been progress.

The progress of the company at Mossel Bay, now known as the "South African Fisheries," has been steady and substantial. An additional steam trawler was procured and a large cold storage erected. Mossel Bay is the nearest port to the trawling ground, and is now in communication by rail with Johannesburg and other towns in South Africa, and these have been important features in the past development of the fishing industry at that centre. The enterprise of the " South African Fisheries " has gone a step further, and they have installed modern plant for the conversion of waste products of the fisheries, including inedible fish such as dogfish, etc., into valuable poultry and stock foods.

The progress of the trawling industry at Capetown has been more marked. By means of well-equipped steam vessels it was found possible to bring fish in good condition to Capetown from the Agulhas Bank, even from distances of over 150 miles. This growth of the industry at Capetown was not attained without serious risks and disappointments. The stormy Cape seas, with their unknown currents and other dangers, led to the loss of many valuable vessels—about a dozen fine trawlers have been lost in this way; the market was uncertain; fish, though abundant, sometimes shifted their localities and could not be found. At times it appeared as if the enterprise would have to be abandoned, but it was at last put on a sound and permanent basis. And then the old complaints arose as to the destruction of young fish and fish spawn by the trawlers, even on these distant fishing grounds, and there were dark hints as to a " monopoly " in trawling.

Successful Establishment of the Industry.

The ultimate result, however, was that the fish supply to South Africa was more than doubled. There are now ten trawlers at work on fishing grounds previously untouched.

The trawlers have been at work now in South Africa for about fifteen years, and, although there is at times a marked fluctuation in their catches.

especially in the case of soles, there is no indication that this method of fishing is causing any diminution of the supply. Each trawler on an average lands about 15 tons of fish per trip of seven to ten days.

If there is such an increased supply, why is it, it is sometimes asked, that the public do not seem to benefit? The consumer seems to be as badly off as before. Snoek and crayfish in the old days could be procured at a few pence each, and the " Pieter Faure " at one time supplied Capetown with cheap fish. This is a common though fallacious argument. It is true that the first effects of an increased supply is a reduced price, but this is only temporary, as the increased supply opens up new markets and involves more capital and expenditure.

This has been the case in the South African fish supply, for at the present time there is a strong feeling that attention should be directed to the further development of the industry, in order to provide a steadier and larger supply of fish at possibly reduced prices.

The initiative in this direction was taken by the Advisory Board of Industry and Science, who brought the matter to the attention of the Government, and, as a practical step, recommended that the fisheries survey, temporarily suspended, should be resumed. In the former survey only a small part of the possible fishing area in South Africa was explored, and there still remain extensive regions, particularly on the Agulhas Bank and the West Coast, which have never been visited by any trawler or fishing boat.

The recommendation of the Board of Industry and Science was accepted and a survey commenced with promising results.

The development of the fisheries as an industry which will be of fundamental importance in any country often depends on a few simple factors. The primary condition is, not that there be an abundant and varied supply of fish, but rather that a few, suitable as regards their food value and adaption for preservation and transport to the great markets of the world, should occur in sufficient quantities. Thus the cod, the herring, and the sardine of the Northern Hemisphere are the foundations of the wealth that has accrued to countries possessing such resources. In countries with a large population and local markets, fish such as flat-fish, not suitable for transport, are also a great source of wealth, but where there is a limited fish-eating population and local market in countries such as South Africa, suitability for transport is as necessary as abundance and food value of the available fish. In such countries not only is the development of the industry hampered by lack of market, but such markets as there are are more readily supplied from other countries which have the suitable fish, and can, by skilled methods of preservation and production of large quantities at cheap rates, readily check all local progress, even by importing at a small profit, if only for a limited period, as has happened in South Africa.

The Chief Marine Products.

In estimating therefore the potentialities of the industry in South Africa and indicating the direction along which expansion may proceed, we may first consider the chief kinds of marine products which occur in sufficient quantity and are suitable for export and overseas markets.

The *snoek* (*pike*), or *seesnoek*, as it was first named by the early Dutch settlers, is characteristic of the Southern Hemisphere only. It occurs in Australia, but apparently not in the same abundance as at the Cape, being known there as the barracouta. It is a fish of the colder waters, being found mostly on the west coast of South Africa, less frequently on the south coast, and never on the east coast, except at Port Elizabeth on rare occasions. It was in early times found in

such abundance that it was practically unsaleable in the season, but as it is a fish which preserves well in salt, whether whole or cut up in small pieces ("mootjes"), quantities were sent inland, and, at a later date, it was largely exported to Mauritius, where it was much appreciated by the Indian population. Of late years it has been found to occur also on the west coast beyond the Cape Province, near Walvis Bay, in the summer-time. The supply is assured, though liable to fluctuation, and the trade in this fish could probably be considerably developed if new markets were opened up. Attempts have been made to find a market as a smoked, salted, or even canned article in the European market, but it has not so far been favourably received. This may be due to the fact that the flesh has a characteristic flavour unlike that of other fish. No doubt the unfamiliar flavour is against its ready acceptance, but may prove in its favour if once established. The fish does not keep well in the fresh state and is not adapted for preservation by freezing, but as salted, smoked, or canned, might find a market in Europe or South America. It is a suitable article of food which might be introduced to the large native population in South Africa, who are, however, not accustomed to a fish diet, having unreasonable prejudice against fish as food.

The following is a brief review of some of the South African fish of importance in the fishing industry, but more especially of those of importance in its future development.

The *stockfish* (*cod*) was so named by the early Dutch settlers on account of its resemblance to the European cod, called stockfish in Holland. It is the fish which Bullen, in the narrative of some of his sea voyages, describes as fine large cod which he found on the Agulhas Bank, off the Cape. The cod family includes several representatives of great commercial value, which, however, are chiefly found in the Northern Hemisphere. In the Southern Hemisphere the family, as a rule, is of little economic importance, being represented by species which are of comparatively little commercial value on account of small size or limited number. The stockfish of South Africa is, however, an exception to this. It is a large fish, scientifically more related to the hake, and its flesh is of a particularly fine flavour. It may be utilized in the fresh state, and is well adapted for preservation, more especially as smoked fillet. In earlier times it was erratic and uncertain in its appearance, and there was no steady supply which could be depended on. Since the advent of the trawlers, however, the supply has been more dependable, and the recent investigations of the Union Fishery Survey vessel, the "Pickle," have shown that the fish occurs in large quantities in the deeper waters (over 100 fathoms) not far from Capetown. This fish will probably prove the mainstay of the export trade. Already in South Africa it has, as smoked fillet, replaced the filleted cod which had been imported from Europe in large quantities. Recently a Canadian firm, apparently unaware of this, imported large quantities of smoked filleted cod from that country, and it had to be disposed of at prices which were not at all favourable, and the experiment will probably not be repeated.

A promising market for the fish has recently been opened in Australia. Like South Africa, Australia has been dependent on importation from Europe for a supply of smoked filleted cod, but, unfortunately, has no local fish which could supply the want, as South Africa has in the stockfish. The want of this is partly supplied by an excellent fish imported from New Zealand called the "blue cod," though it belongs to the perch family. The Cape fish has met with ready acceptance in the Australian market, as it supplies

a long-felt want, and, as in South Africa, it is largely replacing importation from Europe.

I am indebted to Messrs. Irvin & Johnson, to whose enterprise the recent great development of the Cape Fisheries is due, for the following figures showing the progress of the export trade:—

	Cod Fillet. Boxes of 14 lb.	Soles. lb.	Fresh Ling and Cod. lb.
June–December, 1921.....	6,300	Nil.	Nil.
January–December, 1922.....	26,200	21,210	31,700
January–November, 1923.....	108,360	33,712	244,800

The *kingklip fish* (*Genypterus capensia*) is a large fish resembling the European ling; in fact, in New Zealand, where an allied species occurs, it is known by that name. Both in South Africa and Australia it is highly prized as a food fish. In South Africa it was not well known, and was not procured in any abundance till the advent of the trawlers. Like the stockfish, it frequents the colder waters and has been shown to occur, like this fish, in deep waters. Recently a considerable export trade has arisen in this fish in South Africa, not as a smoked article, but in the frozen state, the flesh being well adapted to this treatment, which is not suitable for the snoek. With the gradual exploration of the deeper waters of the west coast the trade will probably develop considerably.

Kabeljaauw or *silver salmon* (*Sciæna hololepidota*) belongs to a family of fishes which is widely distributed in the Northern and Southern Hemispheres. The name "kabeljaauw" is applied to it in the Cape, "silver salmon" in Natal, the latter name having probably reference to the silvery colour characteristics of small specimens. The South African fish is chiefly allied to the European "maigre" (*Sciæna aquila*) and to the Australian "jewfish" (*Sciæna antartica*). It is captured at the Cape in quantity, both by line fishers and trawlers, but is not found in deep waters like the stockfish and the kingklip fish. It is a voracious and an omnivorous feeder, and perhaps for this reason it is often found at the estuarine portions of rivers, where, with favourable food supply, it often grows to a very large size. It is an important fish in the ordinary line-fishing industry of the Cape fishermen, as it occurs in fairly shallow parts and does not migrate from place to place so much as several of the other fish of chief economic value. It is more abundant in the cold waters of the west and south coast.

Geelbek or *Cape salmon* (*Otolithus aequidens*) belongs to the same family of fishes as the kabeljaauw. It is found chiefly in the warmer waters, and, though quantities have recently been found on the west coast, its occurrence there is sporadic, while it is abundant and of much more constant occurrence on the east coast. At the Cape it is of about the same value to the fishermen as the kabeljaauw, and the numbers caught are about the same. The institution of trawling, however, has made a great difference in the relative value of these two fish, for the geelbek, being a surface-swimming fish and not a ground feeder, is very seldom procured by the trawl. The consequence is that the value of the kabeljaauw is now very much greater in the South African fisheries than it has been recently.

The *albacore* or *geelstaart* (*Seriola lalandii*) may be placed near the geelbek; though belonging to another family, it has somewhat the same habits. It is a surface swimmer like the geelbek, and is also a summer fish, though both fish are sometimes caught in large quantities in seine nets; they are not of primary economic value in

South Africa, especially the albacore. The geelbek fishing might, however, be developed by the more extensive employment of suitable set nets. The albacore of the Cape is not the large pelagic fish allied to the tunnies, which usually bears this name. It is widely distributed in various parts of the Old and New World and has a great variety of local names, such as kingfish, amberjack, haken, etc.

The *silverfish* (*Dentex argyrozona*) and the *panga* (*Pagrus laniarius*) are small red fish of considerable importance for the line fishermen and the local market. They are also procured by the trawlers in quantity, but are not of much relative value in their catches. The first experiment of smoking South African fish was carried out with the silverfish with considerable success, and they found a ready market. The two fish are common at the Cape and form a sort of standby, which can be relied on when larger and more valuable fish are not to be procured.

The *white stumpnose* (*Chrysophrys globiceps*) is also one of the smaller fish belonging to the same family as the panga, but not occurring in the same abundance. The *red stumpnose* (*Chrysophrys gibbiceps*) is a much larger fish of a brilliant red colour, but not in great abundance nor of importance to the industry.

The *seventy-four* (*Dentex undulatus*) and the *elft* (*Pomatomus saltatrix*) are migratory fish, the former confined to South Africa, the latter of world-wide distribution. The " seventy-four " is not so abundant in the Cape seas as in Natal, where it forms an important item in the local industry. Neither are of importance, except for local consumption.

The *harder* or *mullet* (*Mugil capito*) and the *maasbanker* or *horse-mackerel* (*Trachurus trachurus*) are apparently identical with species found in other parts of the world. They are procurable in abundance, and the former has been salted and dried in quantities for the use of the farming population from early times in South Africa. The *mackerel* proper (*Scomber colias*) is also abundant in South Africa, but does not find a ready market. If salted and exported to America or other countries where this fish is appreciated, it might find a better and wider market. Its great abundance is a promising factor for the success of any such experiment. Like " harders " and " maasbankers " it occurs in nearly all parts of the world.

Amongst the other smaller fish of less importance may be mentioned the *hottentot* (*Cantharus Blochii*), which is procured in large numbers, chiefly on the west coast, the *galjoen* (*Dipterodon capensis*), but much fewer in numbers, the *roman* (*Chrysophrys cristiceps*), *steenbras*, and others.

The *flat-fishes* or *soles* are, from an economical point of view, to be placed on a different class from all the preceding fish, which are sometimes referred to as coarse fish in contrast to them. They are of value not merely from a food point of view, but on account of their fine flavour. Much of this flavour is lost after any process of preservation, and their chief value is in the fresh or chilled condition. It is possible that a suitable method of preservation may be devised to preserve the fish for export, and this would be a great gain to such countries as South Africa, where the market for fresh fish is limited. Especially is this the case in this country, for it is fortunate in having an abundant supply, as has been amply demonstrated in recent years. Some fifty different species are now known to occur in South African waters, but, as is the case in other fish, variety is not of so much practical importance as size, good flavour, and the possibility of procuring an abundance by the trawl. Thus, in the warmer waters of the east coast there are forty species as against ten in the colder waters of

the west, and of these ten, only two are procurable in abundance, and one of these, though very large and plentiful on the west coast, is not generally considered to be of a very fine flavour. The most important is a sole (*Synaptura pectoralis*) known as the *mud sole* or *Agulhas sole* and found in great quantities on the Agulhas Bank. It was first found in 1898 in the " Pieter Faure " Survey, and this ground has been fished regularly by trawlers for about twenty years without producing any noticeable diminution in the supply. The South African market has therefore been well supplied, and fair quantities are exported, as shown by the preceding export figures.

In its fish supply South Africa, it would appear, is more favoured than any other country in the Southern Hemisphere and may be compared favourably with some of the larger fish-producing countries of the Northern Hemisphere, especially as its resources are not yet sufficiently investigated. In one respect, however, it is decidedly more favoured than any other country, and this is in its supply of the Crustacean, known as the *Cape crayfish*, *spiny lobster*, or *kreeft*. A spiny lobster of the same species occurs in Australasia, but not in the same abundance; another species occurs in California, where it is the basis of a limited industry; and one in Europe, especially on the French coast. This last species is well known and highly appreciated in France, where it finds a ready market under the name " longouste," and probably for this reason the beginning of the Cape industry in this article was dependent on the French market. France is still the chief market, but experiments in exportation to England and America are promising. Since the first success by a company in Saldanha Bay, the industry has rapidly extended and proved very profitable, and there are now about a dozen factories in the Union, which in 1921 exported over twelve million lobsters. The operations of the factories have gradually extended to the north, and it has recently been found that the lobster occurs in abundance on the coast of South-West Africa. Four large factories started last year at Luderitz and have exported already over three million.

Fears have been entertained that this great drain on the supply may seriously affect the industry, as has been the case of the lobster of the Northern Hemisphere, and certain regulations as to size, close season, etc., are enforced by the Government, which so far seem to have been efficacious, but careful attention will have to be paid to the result of extended fishing operations.

It has recently been found in the course of the Government Fisheries Survey that another species of spiny lobster occurs in large quantities off the east coast. It was previously unknown and may at some future time prove of considerable value.

Other Fishery Resources.

This last fact suggests a consideration of other fishery resources, which present great possibilities of future development.

The Cape fish, variously called the *sardine*, *pilchard*, or *herring* (*Clupea aagax*) occurs on the west coast in very great numbers, and it is this fish which constitutes the main food supply for such important fish as the snoek and stockfish. It is closely allied to the European pilchard, and the species found in the Cape seems identical with one found at Japan and California. In Japan it is the most important fish in the industry and is extensively utilized in California. It is surprising, therefore, that it is at present practically quite neglected in South Africa. There have been various attempts to develop the sardine industry in South Africa, but with no success, the chief obstacles being apparently the uncertainty as to the

occurrence of the fish and its habit of keeping well offshore, except at certain times. It is, however, utilized to a limited extent, small quantities being salted and used by the fishermen themselves, or sent to Johannesburg, where there is a ready sale for it.

In view of the enormous demand for sardines, and even for inferior substitutes, under such names as " crossed fish," etc., it is remarkable that no serious attempt has been made to exploit the South African fish which is a true sardine.

The *ansjovis* or *anchovy* (*Engraulis capensis*) also occurs in abundance in the South African seas. It is closely allied to the European anchovy and is of equal commercial value, but has received practically no attention from an economic point of view. Most Cape fishermen are not indeed familiar with the fish, though some of the Italian fishermen at Capetown know it well, and preserve it in small quantities for their own use. The neglect of this valuable asset in the fishery resources of South Africa may be due to valid reasons, similar to those mentioned in the case of the sardine, but it is more probable that the initial outlay in testing the practicability of success and the financial risk involved have prevented any serious interprises by private firms, who have not a knowledge of the possibilities of the industry in South Africa or the necessary steps to be taken for its development.

CHAPTER XI.

VEGETABLE FIBRES AND THE SPINNING INDUSTRY.*

ALTHOUGH the spinning of vegetable fibre is one of the most ancient of the world's industries, it has not, so far, received much attention in South Africa.

Our primitive native races contented themselves principally with skins for dress (which did not amount to a great deal) and strips of hide or perhaps bark fibre, if anything in the nature of cordage was required; despite the fact that fibrous plants of many kinds were indigenous to the country, the fibrous contents of these were little known and certainly seldom used.

It is not the writer's intention to detail the known merits of all these plants; space does not permit. Special mention will be made of the better known fibres, indigenous and otherwise, which offer definite commercial prospects. Further particulars of the plants herein mentioned can be obtained from our Department of Botany—this article merely deals with the possibility of utilizing, in a commercial way, fibres which cannot help being conspicuous amongst our large assortment.

Cotton is not within the scope of this particular article.

The following plants have been discovered wild in many parts of the country, chiefly in Natal and parts of Zululand:—

Sida rhombifolia (Queensland hemp),
Sida capensis.
Sida cordifolia,
Sida carpinifolia,
Abutilon indicum,
Pavonia columella,
Pavonia macrophylla,
Hibiscus gossypinus,
Hibiscus cannabinus,
Hibiscus physaloides,
Hibiscus sabdariffa,
Triumfetta pilosa,
Triumfetta rhomboidea,
Triumfetta effusa,
Grewia caffra,
Corchorus trilocularis,
Urera tenax,
Cannabis sativa,
Gomphocarpus physocarpus,
Lasiosiphon meisnerianus,
Lasiosiphon amthylloides,
Lasiosiphon macropetalus,
Dais cotinifolia,
Peddiea Africana,
Syncolostemon densiflorus,
Syncolostemon lanceolatus,
Sesbania aculeata,
Crotolaria striata,
Crotolaria lancelata,
Kniphofia alooides,
Kniphofia Rooperi,
Sansevieria thyrsiflore.

Amongst those which call for special mention we have *Hibiscus cannabinus*, known in India as Ambara or Deccan hemp, also known as Bimlipatam jute.

This fibre is well suited to the manufacture of gunny bags, seaming twines, hessian, and the coarser types of cordage; in short, it fulfils the many uses of jute.

The imports into the Union during the year 1922 of grain, coal, and sugar bags amounted to £809,975 in value.

* By the late R. F. Maclagan, Johannesburg.

No details are given in the Customs statistics of seaming twines for sewing up bags, or ordinary shop twines. Quite a substantial amount, however, must have been used in this direction, apart from the value in bags.

There is no reason why South Africa should not grow *Hibiscus cannabinus* and spin its own bags. These are at present imported into the country—principally from India and the British Isles. *Hibiscus cannabinus,* which is an annual, grows wild in the districts of Natal, the Eastern Cape Province, Zululand, and in many parts of the Transvaal—in fact, in the latter Province it is considered a weed. Its cultivation has never been seriously exploited. The seed of this plant was a long time ago transported from Africa to India, where it has been successfully grown and marketed generally under the name of Bimlipatam jute. The market price of the Indian grown *Hibiscus cannabinus* at the time of writing is about £21. 10s. per ton c.i.f. United Kingdom ports. It is estimated that at least one ton per acre of clean fibre will result if grown under favourable conditions, the yield of this plant in India is said to be from one to two tons per acre.

The fibre is ripe for extraction about five to six months from the time of sowing, and is extracted by means of retting. The plant attains a height of five to eleven feet in its wild condition, and no doubt, if properly cultivated and sown at proper intervals, it should attain to a more uniform height—branching by close sowing would also be prevented. *Hibiscus* thrives best on dry, sandy, and well-ventilated soils and requires but little rainfall.

Cannabis sativa. a native variety of the true hemp of commerce, grows freely in many parts of the country, but has not yet been cultivated for its fibre-content. It is only known to the natives for its intoxicating constituents. The native variety is generally known in South Africa as "Dagga."

It is not suggested that the indigenous varieties be cultivated for fibre; mention is here made of its wild growth as a point in favour of growing the better varieties, such as are grown in China, Italy, America, and other parts of the world. If the indigenous kinds thrive so vigorously on our soil, it only seems reasonable to suppose that the more domesticated members of the hemp family should do equally well.

Hemp has been known to the human race since the Dark Ages and is capable of being spun into the finest of threads, linens, lawns, and tissues. It is a hardy annual, not susceptible to frost, and grows luxuriously in response to warmth, fertility, and moisture. It is a good drought-resister and is not favoured by insects on account of its peculiar juices; it also holds its own against weeds once it is established. Hemp requires careful retting, which process consists of steeping the bundled stalks for a time in water, the action of which decomposes the gum substance surrounding the fibre. When these gums are dissolved, the fibre is ready for stripping from the stalks and thereafter cleaned. The yield per acre should be about 1,500 lb. of clean fibre when grown under favourable conditions.

The plant is ripe for harvesting about ninety days after it has been sown. The fibre-content, as compared with the total weight of the green plant, is high, being about 9 per cent.

Hemp, unlike cotton and flax, has the advantage of taking very little out of the soil. If the refuse (green leaves and waste stalk) is returned to the land, the same land can be used over and over again for many years without resorting to artificial fertilizer. The market value for good, clean, lustrous hemp, at the time of writing, is about £66 per ton at United Kingdom ports.

Besides its uses for the finer fabrics, hemp is eminently suitable for the manufacture of canvas and the better qualities of cordage.

"Linum usitatissimum" (Flax).

Experiments in the growing of flax for fibre have not resulted in any great success in the past, although flax is now being cultivated in Durbanville, Cape Province, where the yield is said to be good, as much as three tons per acre having been obtained; no statistics, however, are as yet available quoting definite figures, the industry only recently commenced. Flax, without doubt, will do well in certain selected parts of South Africa, but is not of so hardy a nature as hemp; it requires a rather low, even temperature, and a very regular rainfall—conditions, generally speaking, not prevalent in the Union.

The grower of flax is compensated in its somewhat difficult growth and preparation by its high market price, which is for a good, clean, well prepared product, about £90 per ton at the time of writing.

"Phormium tenax" (New Zealand Hemp).

This useful plant has been successfully grown, though not in commercial quantities, in many parts of the Union. It exists in several varieties and there is no doubt that there are large areas in this country perfectly suitable for its cultivation. The plant, when ready for cutting—about five to eight years after planting the roots—yields a leaf of approximately three to ten feet long according to the conditions under which it is grown. The length of time before it reaches a producing stage is certainly a drawback, but this is offset by the high yield and the long life that the plant enjoys. It is computed that cultivated *Phormium tenax* yields seven tons of leaves per acre, the yield of fibre, compared with the weight of green leaf, is from 10 to 14 per cent., which means a harvest of about one ton per acre per annum. It also enjoys the advantage of not needing the retting process. The leaves are readily stripped by means of a small decorticating machine or stripper made for the purpose, very little fibre being wasted in the process; further, by reason of its high fibre-content, the problem of handling and transporting to the mill when in its green stage, is not so serious as in the case of other fibres, such as *sisal* and *Furcraea* herein after mentioned. The market value of *Phormium tenax* c.i.f. United Kingdom ports is about £32 per ton.

"Furcraea" and Sisal.

Among the classes known as hard fibres which have been proved to thrive in the Union are *Furcraea gigantea*, known as Mauritius hemp, and *Agave sisalana*, known as sisal hemp. With the exception of cotton and flax, the above are the only two fibres commercially exploited in the Union; therefore, a more detailed description as to their history, special features, and methods of cultivation, may be of interest.

The *Furcraea* plant was originally imported from Mauritius about thirty-five years ago and is successfully cultivated on the south coast of Natal. More recently *sisal* was imported from Mexico. The yield of both *sisal* and *Furcraea* are very much the same, hence these will be treated collectively. The fibre from *sisal* is coarser and stronger for rope-making purposes than *Furcraea*, which latter, although not quite so strong, is finer and softer and therefore more suitable for lighter cordage.

The percentage of the dry fibre, as compared with the weight of the green leaf, is higher in *Furcraea* than *sisal*. Extraction from *Furcraea* is about 4 per cent. as against 3 per cent. from *sisal*. Under correct conditions, however, *sisal* yields a higher leaf return per acre, which compensates for the lower fibre percentage.

In both cases the first cutting of the leaves is not recommended for four to five years after the bulbil (the young plant) has been planted. It is a mistake to cut the leaves when not properly matured, as the resultant fibre is defective in strength and also the percentage in weight obtained will be less. The more the leaf is matured, the better return of fibre percentage and strength—only leaves that do not stand more than 30 degrees from the horizontal should be cut. Both *sisal* and *Furcraea* grow a pole from the centre when the bearing life of the plant has come to an end. The pole, which usually attains a height of twenty-five to thirty feet, grows very rapidly, and when fully grown, flowers at the top; these flowers develop into bulbils (resembling a small onion), and as they increase in weight the pole bends down, and eventually, when the bulbils are mature, they are scattered about the surrounding ground, where they take root; proving their hardihood by growing in the most surprising places, sometimes in clefts of old tree stumps and crevices in rocks, or in such places where it is difficult to see how they could possibly exist.

The young bulbils under these conditions continue to grow and throw out roots, which eventually come into contact with the earth, where they soon firmly establish themselves.

These young plants are either weeded out or are replanted in a nursery, otherwise the plantation would soon become overcrowded.

Sisal is planted either from the small plants (known as suckers) which spring up round the mother plant, or from the bulbil.

Furcraea does not produce a sucker, but grows from the bulbil only.

When originally planting *sisal*, it is generally accepted as being more convenient to plant from the bulbil, although it takes about six months longer to reach the producing stage than the sucker. The bulbil is more easily handled when starting a new plantation than the sucker would be.

Planting Out of Sisal and "Furcraea."

The best practice when preparing to plant out fresh acreage, is to prepare a few acres of well ploughed and harrowed land as a nursery, which should be in the near vicinity of the land to be planted. Bulbils are then planted six inches apart in rows containing eight plants in width, a space is then left before commencing the next series, and so on. This space is used as a path to enable the workers to operate easily among young plants for weeding and transplanting purposes, etc.

It is advisable to keep the young plants at least six months in the nursery before planting out into their ultimate destination. It is also advisable when taking any plants from the nursery to remove every other plant, thus when these have been transferred there will be one foot between the remaining plants; another removal means two feet space, and so on. As the young plants start putting on considerable growth at about this stage, the air space becomes increasingly necessary.

It will be seen that by adopting this nursery scheme, nothing is being retarded in the growth of the plant or the planting out into their ultimate acreage. Ploughing operations and the preparing of the soil goes on when the young plants are growing. A nursery of four acres thus described is sufficient to supply 500 acres of plantation. Owing to the hardiness of the young plant, it is not necessary to water after transplanting, providing that rains can reasonably be expected, say, within a month from the time of transplanting. Naturally, the sooner the rain comes, the more quickly will it become established. Anyway, it is better to have everything prepared and the holes dug out in readiness in preparation for the rains.

As there are no seasons for planting *sisal* or *Furcraea*, planting out is actually a continuous operation governed, of course, by any such time as it rains.

Soil.

It is sometimes considered that *sisal* and *Furcraea* will flourish on dry and stony soil, and though the plants are of a stunted appearance, the percentage of fibre as compared with the weight of green leaf is more than that of the longer and well grown leaf produced on good soil.

Under these conditions, however, the return per acre is certainly not so good; the length of the leaf is also a most important factor—to a large extent governing the market value of the fibre. For these reasons it is not recommended to grow on cheap waste land, such as some writers contend can be used with great advantage. Experience in Natal proves that well-drained, sandy soil from which the natural bush has been cleared produces the best results. It is very important that plants should be grown on land well sheltered from wind. If grown on exposed parts, even on the best of soils, the plants are stunted and appear to pole much quicker than those grown on more sheltered localities.

Although this article is based on conditions experienced in Natal, where, as stated, both *Furcraea* and *sisal* do well, there is no reason why other parts of the Union should not be just as suitable. The climate of the south coast of Natal is semi-tropical; frost, except in the deep valleys, is unknown. It so happens that the temperature and humidity of the Natal coast suits both these plants. It is important to remember, however, that *Furcraea* is a semi-tropical and *sisal* a tropical plant; therefore, conditions existing in more tropical parts would suit *sisal* better than they would *Furcraea*.

Conditions necessary for *Furcraea* and *sisal* (especially *sisal*) are: Rainfall not less than 35 inches per annum; absence of frost; altitude not higher than 2,200 feet. These conditions are met with in the following parts of the Union:—

The coast-belt north of Port St. Johns, the lower parts of the eastern Transvaal, and Swaziland; in fact, all territory roughly east of 31° longitude.

Fertilizing.

Various opinions exist on this somewhat complex question. If the soil is too rich, enormous leaves, mostly pulp, are the result; and although these produce a very long fine fibre, the percentage of fibre as compared with the weight of the green leaf is out of proportion; consequently, handling and transport to the mill become expensive.

It would, therefore, appear that fibre plants can also have too much of a good thing, so if the land happens to be too rich, instead of the virtue in fertilizers going into fibre, they go into worthless pulp. The pulp, or waste—sometimes called bergasse—from the decorticator (the machine which separates the pulp from the fibre) can advantageously be put back on to the land; not only does the pulp contain manurial properties, but also it is a good way to get rid of what otherwise would be a nuisance owing to its unpleasant smell when fermenting.

Another method is to allow the pulp to dry, then stack and burn it. The ash can then be used as a fertilizer. One of the safest fertilizers to use in the long run is limestone, which indirectly imparts a slow but lasting benefit to the soil.

Planting.

Different growers have their own ideas on the distance apart that plants should be spaced. There are those that favour a more intensive growth and then again those that believe that the more room and air space a plant can get, the better the ultimate result.

A point in favour of intensive growth is that as long as the land is kept strictly cleared from weeds when the fibre is in its early stages, the weeds have no chance against it when thoroughly established, the weeds being shut out from the sun. On the other hand, if planted too closely it is only reasonable to expect that the leaves will not develop when cramped and limited to air.

A safe medium distance to plant *sisal* is six feet between each plant and allowing eight feet between each row.

With *Furcraea* the leaves grow rather longer than *sisal*, but no more spacing than in the case of *sisal* is usually practised.

The following figures show the number of plants to the acre when spaced as shown:—

Planted.	Number per Acre.
6 by 8 feet	907
7 „ 7 „	889
8 „ 8 „	680
8 „ 10 „	544

It will be seen that nearly double the number of plants to the acre can be planted when spaced 6 by 8 feet than when spaced 8 by 10 feet.

Cutting.

This, in Natal, is carried out by natives, both men and women. The implement used is an ordinary sickle. The leaf is cut off to within about 2 to 3 inches of the extreme juncture or butt of the leaf.

The natives are usually paid on what is known as the task system, which means that they are paid for a certain quantity of cut leaves brought in bundles to the nearest collection station irrespective as to the time taken to do the task. Everything depends on their individual hard work.

The task is set by the overseer and framed to suit conditions, such as nearness to collecting centre, condition of leaves, whether hill-side fibre is being cut or from level ground. The average task amounts to about 1,600 leaves, or approximately 3,000 lb. in weight. The native has little idea of weight and is generally suspicious of weighing machines; therefore, simple measures, permitting of no argument, are adopted to adjudicate as to whether the task has been properly fulfilled or not. One method is to stipulate the number of bundles of certain girth, a measuring string, which must exactly encircle the bundle, being issued to the worker.

Another more satisfactory method is to drive into level ground two measuring sticks. The sticks for an average task are generally seven feet apart and four feet high from the ground. The bundles must be packed up level with the top of the stick.

Harvesting.

A strong point in favour of the cultivation of *Furcraea* and *sisal*, as compared with most other fibrous plants, is the fact that there are no particular harvesting seasons. The leaves can be cut all the year round as they become mature. Therefore, on the large estate, it is possible to arrange a rotation so that the cutter gangs are timed to take, say, twelve to fourteen months to complete the cutting of the entire estate, after which time the plants first cut are ready to be cut again, thus making cutting a continuous process.

The leaf is its own fibre store-house, and nothing is lost if they are not cut, even when over-matured.

It is recommended that a lighter cutting and oftener should be the plantation slogan. If too heavy cutting is indulged in, not only is this uneconomical, as it means that leaves not properly matured are cut, but it is also reasonable to assume that heavy cutting hastens the poling of the plant on the grounds that the vitality of the plant being suddenly cut off from its natural flow to the leaves causes egress in the pole, which might otherwise have remained dormant for years and thus considerably preserve the bearing life of the plant.

Decorticating.

This process consists of mechanically separating the fibres from the leaf. The first machines used in Natal were of the power-driven, hand-fed raspidor type. The hand-feeding of these machines, however, led to much labour trouble. The leaf, when offered to the scrapers on the rapidly revolving decorticator drums, had to be gripped by hand; owing to the thorny nature of some of the leaves and the stinging juice exuded in the process, it became very difficult to find competent native labourers who would continue for any length of time on this uncomfortable task.

The double-drum automatic decorticator has solved this problem; it is now only necessary to feed the leaves on to a chain conveyer-belt, the machine doing the rest. The modern decorticator is an ingenious device, but notwithstanding all the ingenuity expended on its design, it is rather a regrettable fact—and one of much importance to the fibre industry—that a 3¾ per cent. extraction of fibre from the leaf is considered good, whereas the actual fibre-content in a leaf when carefully and patiently hand-scraped has revealed as much as 8 per cent.

A chemical analysis of the total fibre in *Furcraea* leaves has shown as much as 10.2 per cent. Naturally, in this large difference a great percentage of what is not recovered by the decorticator is not long fibre, but shorts, or tow. The decorticator, if carefully attended to, does not waste much long fibre. The fact remains, however, that even shorts have their commercial value and can be spun into yarn for the cheaper class of cordage trade. Once the pulp containing the short fibre reaches the dump heap, it is questionable whether by hand-sorting it pays to try and recover even a proportion of it. There is no doubt that there is still a serious waste in the present system. Better and more economical methods of extracting these fibres still offer a wide field to those of an inventive turn of mind.

Even a further recovery of 1 per cent. of what is now more or less actually wasted, would mean one ton more of fibre in every hundred tons of green leaves taken to the decorticator, a very considerable saving, and one that could easily turn the scales of a moderate profit into a good one.

It is most important that leaves should be decorticated almost immediately after cutting, otherwise if left for a few days, the juice in them becomes gummy, which makes decorticating both wasteful and difficult.

The following is an estimate based on average conditions, giving some idea of what capital would be required and probable profits earned by planting a plantation of 2,000 acres of *Furcraea* or *sisal*:—

AREA, 3,000 ACRES; 2,000 UNDER FIBRE, 1,000 GRAZING, ETC., PLANTED AT THE RATE OF 1,000 ACRES PER ANNUM.

Total cost of preparing 2,000 acres of fibre in two years, and upkeep for a further two years.

A total of four years = £8. 18s. per acre.

		£	s.	d.
First year.....	1,000 acres.....	6,300	0	0
Second year.....	1,000 acres.....	6,300	0	0
Third year.....	2,000 acres.....	2,600	0	0
Fourth year.....	2,000 acres.....	2,600	0	0
= £8. 18s. per acre.....		£17,800	0	0

	£	s.	d.
Capital Outlay..... (3,000 acres at £1, plus transfer fees and initial expenses.)	3,100	0	0
Buildings..... (House for manager, quarters for assistants, quarters for 110 boys, stables, sheds, etc.)	1,300	0	0
Implements..... (Horses, wagons, carts, harness, and farming implements generally.)	550	0	0
Oxen..... (Say 150 at £8 per head.)	1,200	0	0
Miscellaneous Expenses..... (Fencing, road-cutting, etc.)	150	0	0
	£6,300	0	0

Machinery and Plant—	£	s.	d.
Building	600	0	0
Decorticator, allowing for erecting	1,500	0	0
Gas-engine	1,400	0	0
Line shaft, belting, etc.	150	0	0
Baling press	300	0	0
Brushing machinery	400	0	0
	£4,350	0	0
Total capital required	£30,000	0	0

	£	s.	d.
Capital outlay	6,300	0	0
Working costs—			
First year	6,300	0	0
Second year	6,300	0	0
Third year	2,600	0	0
Fourth year	2,600	0	0
Machinery and plant	4,350	0	0
	£28,450	0	0
To this must be added a reserve to allow for first four months working costs and stock of fibre being unsold, say	1,550	0	0
	£30,000	0	0

Recovery—	£	s.	d.
Fifth year: 1,000 acres at 500 lb. = 250 tons	7,500	0	0
Sixth year: 1,000 acres at 1,000 lb. = 500 tons	15,000	0	0
1,000 acres at 500 lb. = 250 tons	7,500	0	0
Seventh year: 2,000 acres at 1,000 lb. = 1,000 tons	30,000	0	0
Eighth year: 2,000 acres at 1,000 lb. = 1,000 tons	30,000	0	0
Ninth year: 2,000 acres at 1,000 lb. = 1,000 tons	30,000	0	0
Tenth year: 2,000 acres at 1,000 lb. = 1,000 tons	30,000	0	0
5,000 tons =	£150,000	0	0
Equals 5,000 tons at £30 per ton	£150,000	0	0
Working costs, 5,000 tons at £15 per ton	75,000	0	0
PROFIT	£75,000	0	0

Capital, £30,000. Total profit in ten years, £75,000, equal to an average of £7,500 per annum. A total average of 25 per cent. per annum, or an average of 15 per cent. per annum after allowing a return of capital over ten years.

N.B.—The price of fibre at United Kingdom port is quoted at the time of writing as follows:—

No. 1 Sisal	£36
Mauritius Hemp (*Furcraea*)	36

The figure of £30 per ton assumed in these calculations is at a low average market figure and also allows for freight, commission, sundry charges, etc.

Costs assumed in the above estimate are based on a fair average rate ruling at the time of writing—native labour is taken at £2. 14s. per month per native male adult and includes cost of rations.

Cordage Spinning Industry.

The following are the Customs statistical figures of imports into the Union during the year ended 30th June, 1922:—

	Value.
Binding twine and harvest yarn	£38,081
Cordage and rope	36,752

At the time of writing there are three factories operating in the above lines: two in Natal and one in Transvaal. The total consumption of cordage and rope in the Union of South Africa, including the output of the local factories, is probably nearly double the value of the import figures stated.

The fibres used by the local factories are mostly *Furcraea* and *sisal* either grown in Natal, or *sisal* imported from East Africa.

Coil fibre from India and Ceylon, jute, hemp, flax, and cotton from the United Kingdom are also used; these latter are mostly imported in a ready-spun state.

Our Government is anxious to foster industries, and protection against the imported article through the medium of the Customs is generally given to deserving cases—if not reacting detrimentally to the populace in general. Special railway tariffs are also allowed

on material such as fibre in its raw state, this in order to assist the inland manufacturer.

Customs duties at present operating are as follows:—

Imported Manufactured Rope, 20 per cent., with 3 per cent. British Preference.

Cordage such as Shop Twine, etc., 20 per cent., with 3 per cent. British Preference.

Binding Twine or Harvest Yarn, 3 per cent. from Foreign Countries, but free for British Product.

Canvas and Duck, 3 per cent. from Foreign Countries, but free for British Product.

Seaming Twine, 3 per cent. from Foreign Countries, but free for British Product.

Jute and Hessian in the piece—Free of Duty.

Mineral Oils for batching purposes are dutiable to the extent of 3d. per imperial gallon.

Whale and Sperm Oil are produced at Durban and therefore are free of duty. These oils also enjoy a low rate of railage.

If sufficient guarantee were given to the Government that industries starting in the Union are sound and competent to supply all demands, without undue price inflation, also that labour employed, capital expended, etc., is of sufficient importance to improve generally the welfare of the Union, there is every chance of protection being given to foster a new industry, if really necessary.

Jute goods, as already mentioned, such as bags, hessian, and seaming twine, are at present allowed in duty free, probably for the reason that no manufacturers of these goods are seriously operating in the Union.

The writer does not wish to convey the idea that protection in every case is an absolute necessity, although it is only fair that new industries should have every chance in getting a fair start. The soundest protection is to grow and spin more cheaply than anybody else.

With the Union's advantages of low priced fertile land, splendid climate, cheap unskilled labour, cheap fuel, and so many other advantages, surely these conditions, not forgetting a growing market in a new country, are sufficient to induce the enterprising fibre grower and spinner to our shores.

Appendix.

I am indebted to the following authorities for information:—

Indigenous Plants.—E. Holmes-Smith, Esq., B.Sc. (Edin.). See Fibre Plant Investigations, Bulletin No. 50.

Dr. I. B. Pole Evans, M.H., D.Sc., F.L.S. —South African Fibre Plants (*Hibiscus cannabinus*).

S. S. Boyce, Esq.—Hemp (*Cannabis sativa*).

First S.A. Cordage and Spinning Co., Ltd.—*Sisal and Furcraea*.

And to the Department of Mines and Industries, Agricultural Department, Division of Botany, Pretoria, for their courtesy and useful information.

CHAPTER XII.

THE MORE EFFICIENT UTILIZATION OF MAIZE.

The South African maize crop in 1925 *was officially estimated at* 2,400,000 *tons.*

Starch, cornflour, and maizena worth £40,000 *are imported annually. Starch worth* £8,000 *is exported annually. Other maize products (glucose, etc.) are imported to the value of over* £20,000.

There is a market for all maize products in South Africa.

THE Union of South Africa has become known in the markets of the world as one of the foremost fields for the production of maize of good quality. When this important staple crop first came to be generally grown in the country cannot be stated. At first "flint" breeds alone were known. In the last twenty or thirty years, however, there has been a wider recognition of the country's suitability for maize cultivation; with the introduction and acclimatization of many excellent "dent" varieties, maize has come to be the chief grain crop of South Africa. As human food, it mainly supports the five million natives of the country, and it forms the principal concentrate on which South Africa's live stock is fed. The nature of the crop and the methods of cultivation have undergone considerable change as the knowledge of the limitations and possibilities of maize-growing has become clearly defined. The low-yielding "flint" varieties, such as the "Botmans" and the earliest of the "dents" (for example, "North America"), have almost entirely disappeared, except among the segregated natives, who gained their notions of agriculture from their early Dutch masters.

The improved high yielding "dent" breeds (e.g. the "Hickory" varieties, "Eureka," "Chester," "County Mammoth," etc.) were introduced by the Department of Agriculture, and have become generally distributed and thoroughly acclimatized. Improvement has also taken place by constant selection at Government farms and by the successful methods of enterprising farmers.

It may be added that the present system of grading in the Union allows the purchaser to obtain the particular breed and quality of maize required for any specific purpose.

Grading regulations are appended to this chapter.

The areas within which maize can be grown successfully have come to be more or less defined. That a definite maize belt exists in the Union has not always been realized. Mr. J. Burtt-Davy defines the maize belt roughly as the country lying east of 26th meridian, i.e. a line drawn between Algoa Bay, Bedford, Cathcart, Queenstown, Aliwal North Wepener, Bloemfontein, thence north to Lichtenburg and Zeerust.

Grain Elevators.

A national service of grain elevators has been instituted in South Africa. A terminal elevator at Capetown and thirty-three country elevators in suitable localities in the maize area have been constructed, together with one of 2,600 tons capacity in the wheat and oats area at Moorreesburg, which is used only for those cereals. A further terminal elevator of 42 000 tons capacity is under construction at the port of Durban, and when completed will bring the total storage capacity up to 181,200 tons.

The system is operated by the South African Railways and Harbours Administration upon recognized principles. The farmer who obtains a certificate for maize accepted by the elevator can use the document as security against a bank advance, or sell it outright. By this method financial operations are much simplified.

Besides eliminating the greater part of the general wastage that previously occurred, due to exposure to weather, depredations of rodents and weevils, congestion at rail heads, etc., there are further advantages under the new system. Savings result from reduction of labour at the ports, quicker loading and discharge of ships, increase of weight of cargo carried, convenience of storing on board, and reduction of railage and handling charges through the elimination of the bagging system.

Details of rates will be found on a later page.

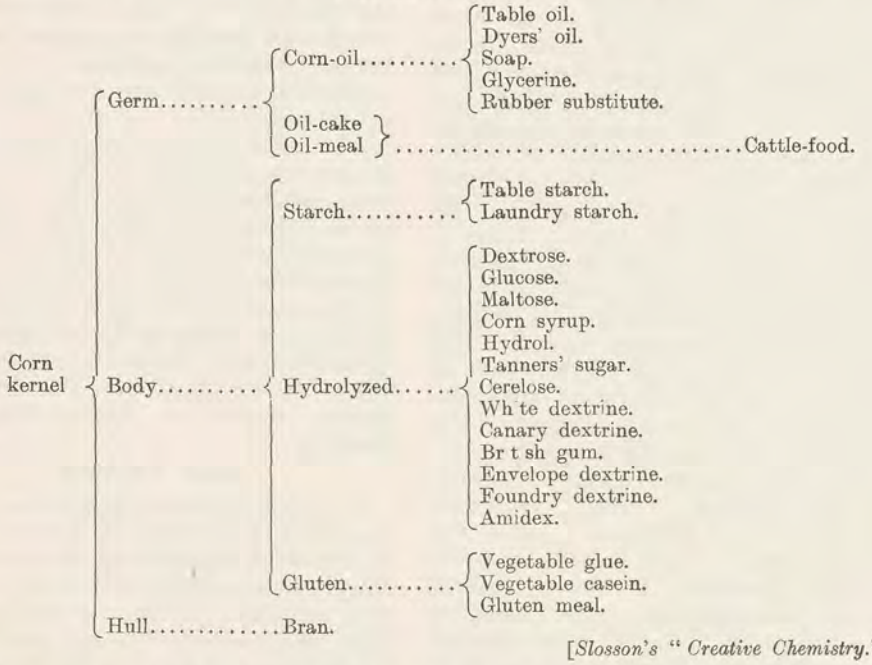
The Maize-product Industry.

One ton of maize yields roughly the following products:—

	lb.
Corn Starch	1,100
Corn-oil	40
Oil press-cake	160
Gluten-feed	500

The actual saleable products from maize, however, are much more numerous, as illustrated in the table of corn products below. Only the "primary" products, however, will be dealt with here.

Corn Products

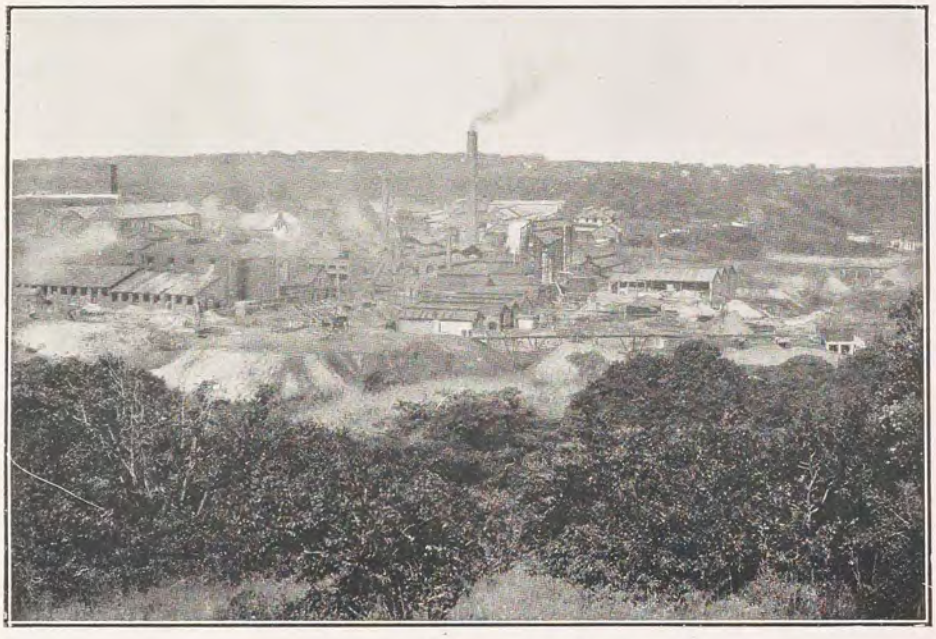


[*Slosson's "Creative Chemistry."*]

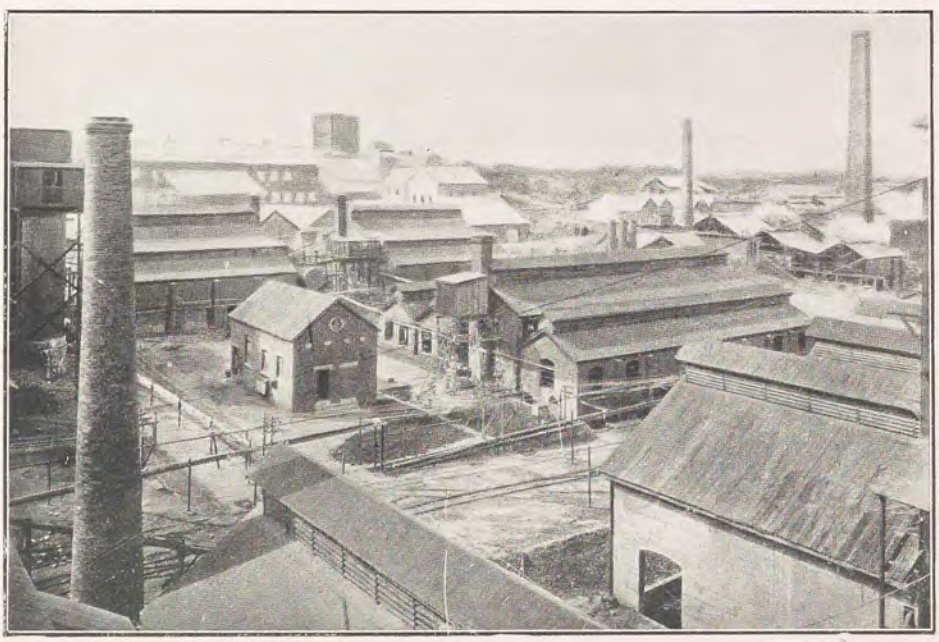
The best way to treat the subject is to take each of these primary products and discuss its possibilities in South Africa.

Starch for all uses and of the best grades is produced in South Africa by the African Products Manufacturing Company, Germiston, Transvaal. This plant is extending its business and intends to manufacture glucose and dextrine in the near future. South African starch has found favour in the British markets, 2,212,752 lb. (worth about £7,931) being exported

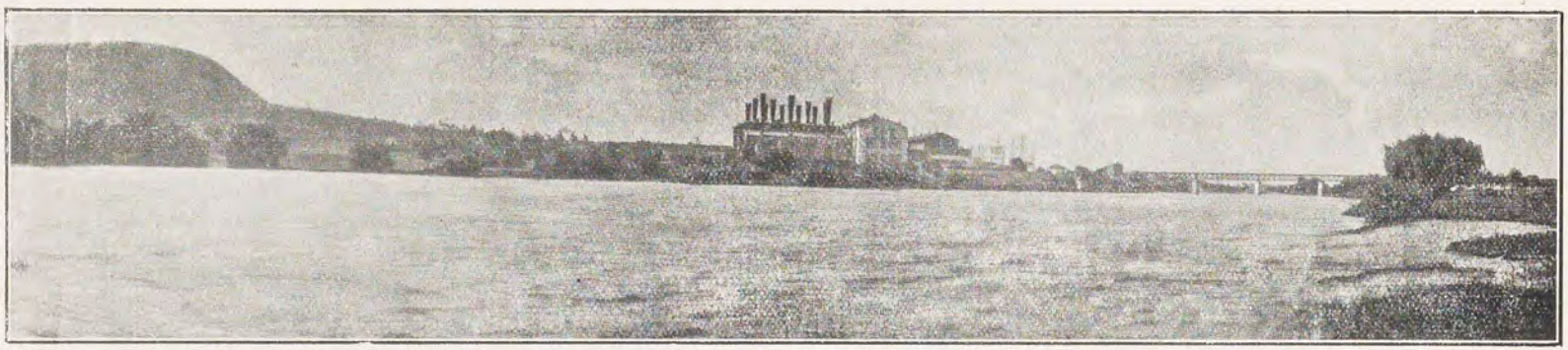
MESSRS. KYNOCH'S FACTORIES AT UMBOGINTWINI,
NATAL SOUTH COAST.



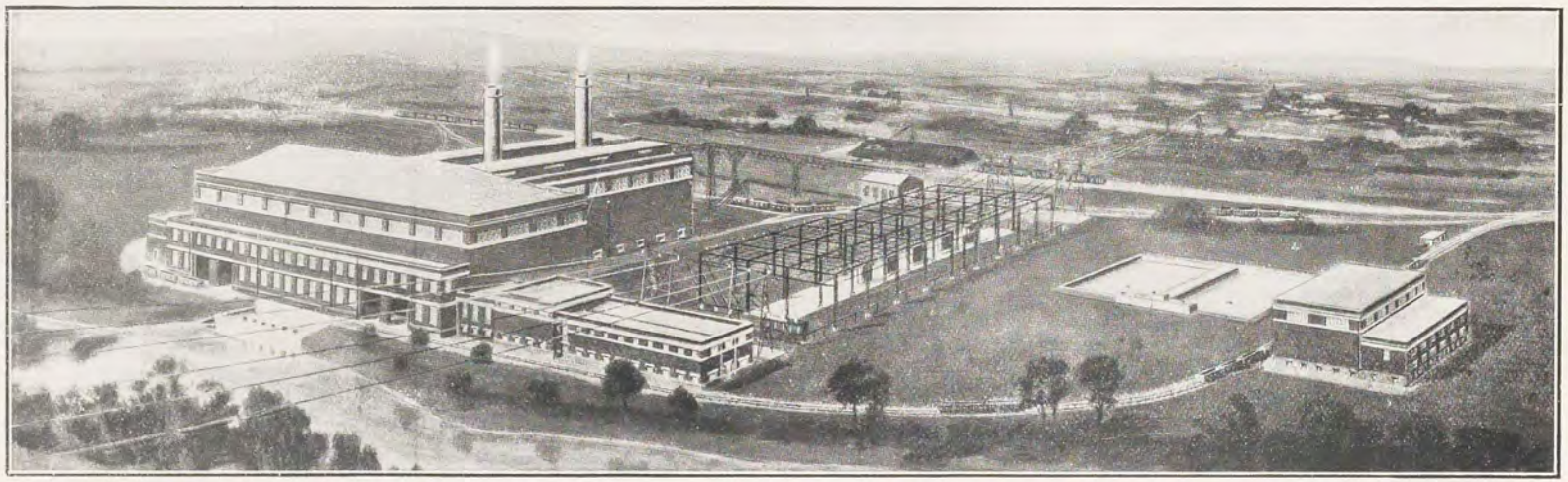
A General View of the Works.



Looking over the Loutrine Control Laboratory and Acid Plants toward the Fertilizer Plant and Mixing Sheds.



PANORAMIC VIEW, VAAL RIVER AND VEREENIGING POWER STATION.



ELECTRIFICATION POWER STATION, COLENSO.

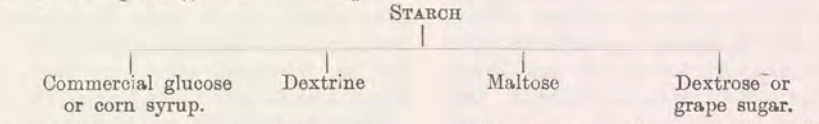
Witbank Power Station : Outside Switch Gear.

1,500-kw. Arc Furnace for Carbide Manufacture, Rand Carbide, Ltd., Witbank. Designed and Built in the Transvaal.

Portion of the main lode exposed in No. 3 trench, Rietfontein No. 3. Shows quartz stringers (white) in felsite (dark).

in 1924; of this, 2,210,240 lb. went to the United Kingdom. At the same time, South Africa imported, chiefly from the United Kingdom, Holland, and the United States, 1,250,405 lb. of starch valued at £20,931 and 1,087,569 lb. of cornflour and maizena, valued at £20,237. The notable point, however, is this—that South African starch is competing successfully in British markets, and there is no reason why this export trade should not expand to much greater proportions.

That, however, is not the only outlet for corn starch. Starch itself may be made of raw material for quite a number of simpler, or at any rate smaller-sized, molecule, carbohydrates. Thus:—



Commercial glucose or corn syrup or "starch syrup" is a widely used product. It is a mixture of dextrine, maltose, and dextrose in fairly definite proportions; it conforms to certain standards of sweetness, and has low crystallizability and the ability to remain uncrystallized when mixed with sugar. To satisfy these conditions, it is found that at least 2.5 per cent. dextrine should remain in the carbohydrates. It is widely used in the manufacture of confectioneries, preserves, jellies, and similar food products. A diagrammatic flow-sheet of glucose manufacture is given below:—

[*Roger's "Industrial Chemistry," p.* 907.]

Dextrine or British gum is a well-known and very widely used adhesive. The finer qualities are also used in confectionery and foods. It is prepared from starch by either of two methods—acid hydrolysis, or straight heating to 100°-250° C. in rotating or closed stationary vessels.

Maltose is another starch product made by the fermentative action of malt diastase on starch paste. This has the same chemical formula as cane sugar, $C_{12}H_{22}O_{11}$, and is an intermediate product between starch and dextrose.

Dextrose is made by the more complete hydrolysis of starch. This is also called glucose; in fact, glucose is its usual name, though commercial glucose is a mixture of three products of starch decomposition as explained above. Starch sugar is another name given to dextrose.

Dextrose comes on to the market as solid glucose; in this form it contains dextrine. It is two-thirds as sweet as sucrose or cane-sugar, and this is a drawback. It is used in making confectionery, cakes, preserves, jams, jellies, syrups, etc.; in fact, in all cases where corn syrup may be used.

The hydrolysis of starch by dilute acids takes place in progressive stages as shown:—

$$\underset{\text{Starch}}{(C_6H_{10}O_5)n} \longrightarrow \underset{\text{Dextrines}}{(C_6H_{10}O_5)n\ H_2O} \longrightarrow \underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \longrightarrow \underset{\text{Dextrose}}{2C_6H_{12}O_6}$$

The difference between corn syrup or commercial glucose and solid glucose is shown below:—

	Syrup. Per Cent.	*Solid Glucose.* Per Cent.
Dextrose.....	40–43	55–61
Dextrine.....	41–46	24–30
Water.....	15–19	15–20

A certain amount of malthose is always present.

For a number of years the imports of glucose have been over 2,000,000 lb. and in 1924 they rose to over 4,000,000 lb. Negligible quantities of glucose, if any, are made in South Africa, though developments along this line, as already mentioned, are contemplated.

We have now considered the possibilities of development in maize utilization as far as starch and its products go.

The other products of maize—oil, gluten, and cattle feed—show equally promising possibilities of development.

Corn-oil has a number of uses. The crude oil is rapidly hydrolyzed if meal be present. By careful refining and deodorizing with superheated steam, however, an edible oil is obtained, which keeps well and has a pleasant taste.

This refined oil is used as salad oil and in cake and biscuit making and general baking work, and also in the manufacture of margarine. Hydrogenated, it serves as a fairly good stiffening ingredient for lard. It is also used for soap-making, though it is somewhat difficult to saponify, and to a less extent in the manufacture of paint.

In 1924, 6,532 gallons of cotton-seed salad oil (valued at £1,063) and a further unclassified 370,000 gallons (150,000 gallons from the United States) of edible oils (valued at £81,386) were imported. A small amount of maize-oil is produced in South Africa, but it is quite apparent that considerable expansion is possible.

The press-cake residue from the extraction of oil is a valuable cattle-feed, which should find a ready sale in South Africa. (A typical analysis is given at the end of this chapter.) The imports of oil-cake amounted in 1924 to 645,300 lb., and the exports to 191,532 lb. (chiefly to the United Kingdom).

Gluten forms the largest proportion of the organic matter associated with starch in maize. Gluten contains up to 40 per cent. protein, and is used either in the form of cake or meal as cattle-feed. This short description outlines the commercial products obtainable from maize.

At the same time 100,000,000 gallons of industrial alcohol are produced from low-grade maize every year in the United States. As a demand for alcohol grows, either for motor spirit or for general industrial purposes, low-grade maize will undoubtedly prove in South Africa to be the source of a large percentage of this product.

Economically, maize is the most important crop grown in the Union. As has been seen, its by-products are many, and there are markets for all of them. Those that are now being exported (for instance, starch) are sold in competition with overseas products, and there is no reason why, with the large quantity of raw material available, the by-products of maize should not be manufactured in South Africa.

As regards the export of maize and maize-meal, a glance at the table of imports and exports appended will show how the former have decreased and the latter increased during the last twelve years. The production, too, has increased to a great extent, and by careful grading and seed selection the quality has improved enormously.

It may be added that South African maize is in quality second to none. No. 1 grade American maize contains 14 per cent. moisture. South African No. 1 contains only 12.5 per cent., which renders it more suitable for the manufacture of maize products.

In one of the largest maize-producing countries in the world there is undoubtedly room for a great maize products industry. It is possible to build up in South Africa an industry in maize products close to the source of the maize, and to manufacture these products at a low cost, owing to the presence of cheap, yet efficient, unskilled labour.

IMPORTS AND EXPORTS OF MAIZE.

	1924.		1910.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	lb.	£
Imports—				
Maize	400	5	56,072	231
Maize-meal	7,916	136	1,460	17
Maize (flaked)	—	—	58,338	314
Exports (South African produce)—				
Maize	143,896,566	492,001	356,303,905	693,413
Maize-meal	114,350,757	386,746	2,594,777	6,168

IMPORTS OF GLUCOSE (1922).

From United Kingdom.	13,752 lb.	(£153)
,, Belgium	4,524 lb.	(£40)
,, Holland	11,840 lb.	(£105)
,, United States of America	2,897,571 lb.	(£19,187)
TOTAL	2,927,687 lb.	(£19,485)

Grading of Maize.

Maize and maize-meal are at present graded as follows:—

Grade Mark to be shown on Bags.	Maize.	
	Class.	Description.
1	Flat White No. 1.....	To be sound, dry, plump, and well cleaned, with a maximum of 1 per cent. of yellow, discoloured, and defective grain.
2	Flat White No. 2.....	To be sound, dry, and reasonably clean, and contain not more than 8 per cent. defective or other coloured grain, or both. Berries may be of irregular size.
3	Flat White No. 3.....	To be sound, dry, and reasonably clean, and contain not more than 13 per cent. of defective or other coloured grain, or both. Berries may be of irregular size and shape.
4	Flat Yellow.....	To be sound, dry, and reasonably clean, and contain not more than 9 per cent. of defective or other coloured grain, or both. Berries may be of irregular size and shape.
5	Round White.....	To be sound, dry, and reasonably clean, and contain not more than 9 per cent. of defective or other coloured grain, or both. Berries may be of irregular size.
6	Round Yellow.....	To be sound, dry, and reasonably clean, and contain not more than 9 per cent. of defective or other coloured grain, or both. Berries may be of irregular size.
7	Mixed.....	To be sound, dry, and reasonably clean, and contain not more than 10 per cent. of defective grain.
8	No grade.....	To include all maize which cannot be classed in a higher grade, but to be in dry condition, fit for shipment, and contain not more than 40 per cent. of defective berries.

Grade Mark to be shown on Bags.	Maize-meal.	
	Class.	Description.
M. 1	White maize-flour.....	To be milled from South African grown white maize, Government standard maize, grades Nos. 1 and 2.
M. 2	Granulated white maize-meal...	To be milled from South African grown white maize, Government standard maize, grades Nos. 1, 2, and 5.
M. 3	Ordinary straight milled white maize-meal	To be milled from South African grown white maize, Government standard maize, grades Nos. 1, 2, 3, and 5 (mesh 18 to 32).
M. 4	Ordinary straight milled yellow maize-meal	To be milled from South African grown yellow maize, Government standard maize, grades Nos. 4 and 6 (mesh 18 to 32).
M. 5	Mixed maize-meal.....	To be milled from South African grown white maize and yellow maize, Government standard maize, grades Nos. 1 to 7 (mesh 18 to 32).

Grain Elevators.

Charges.

A rate of 3d. per 200 lb. for both country and port elevator services, excluding storage.

Storage Charges.

First ten days, free.

Thereafter during the period July to December (both inclusive), 2d. per 200 lb. per 30 days or part thereof.

From January to June (both inclusive), 1d. per 200 lb. per 30 days or part thereof.

At Moorreesburg the charges are identical except that the higher rate operates during the months October to March, both inclusive.

Chemical Composition of different Varieties and Breeds of South African Maize.

Tables Nos. 1, 2, and 3 show analyses, carried out in the Union, of different breeds of South African maize, table No. 2 showing the protein-content only. Table No. 4, which shows the result of analyses of American-grown maize, is given for comparison.

The results show that high-protein maize can be grown in the Transvaal, five of the " dent " breeds averaging as high as, and two of them exceeding, American-grown " dents." Another interesting and valuable point brought out is that " dent " maize may contain as high a protein-content as " flint " maize. The question of the production in South Africa of a maize of high-feeding value therefore resolves itself entirely into one of breeding and selection.

TABLE NO. 1.—CHEMICAL COMPOSITION OF DIFFERENT VARIETIES AND BREEDS.

Description.	Moisture.	Ash.	Crude Fibre.	Nitrogen-free Extract.	Ether Extract.	Protein (Nx6).
Flint Maize—						
White Cango	7·81	2·26	1·70	72·83	5·09	10·31
Vilmorin's Early Yellow	6·92	1·42	1·68	73·98	5·25	10·75
Indian Pearl	7·47	1·88	2·23	71·40	5·40	11·62
Mean of three	7·40	1·85	1·87	72·74	5·25	10·89
Dent Maize—						
Golden King	7·64	1·29	2·28	75·18	4·61	9·00
Hickory King	6·76	1·24	1·68	76·64	4·24	9·44
Yellow Hogan	6·73	1·25	1·91	76·11	4·87	9·13
King of the Earliest	7·27	1·24	2·19	75·49	4·25	9·56
Red Hogan	6·60	1·28	1·75	76·33	4·73	9·31
Early Leaming	6·76	1·27	1·83	75·45	4·63	10·06
Mean of six	6·97	1·27	1·94	75·87	4·53	9·42
Soft or Bread Maize—						
Brazilian flour corn	7·72	1·14	1·51	76·26	4·37	9·00
Mean of ten	7·16	1·42	1·86	74·96	4·74	9·81

TABLE NO. 2.—PROTEIN-CONTENT OF EIGHTEEN SAMPLES OF TRANSVAAL MAIZE.

Variety.	Colour of Grain.	Shape of Grain.	Protein.
			Per Cent.
Improved Early Horsetooth.....Dent	White	Narrow	10·47
Thoroughbred White Flint.....Flint	,,	Broad	10·43
Wood's Northern White Dent.....Dent	,,	,,	10·43
White Cap Dent..... ,,	Yellow and white	Narrow	10·25
Early Star Leaming..... ,,	Yellow	,,	10·07
Extra Early Huron Dent (1)..... ,,	,,	,,	10·06
Extra Early Huron Dent (2)..... ,,	,,	,,	9·93
Yellow Hogan..... ,,	,,	,,	9·91
Iowa Silver Mine..... ,,	White	,,	9·90
Champion White Pearl..... ,,	,,	,,	9·86
Hawkesbury Champion..... ,,	Yellow	,,	9·69
Hickory Horsetooth..... ,,	White	,,	9·64
Austin Colossal..... ,,	Yellow	,,	9·61
Hickory King (good sample)..... ,,	White	Broad	9·34
Chester County..... ,,	Yellow	Narrow	9·30
Hickory King (crossed)..... ,,	White	Broad	9·01
Golden King..... ,,	Yellow	,,	8·98
Wisconsin White Dent..... ,,	White	Narrow	8·58

TABLE NO. 3.—COMPOSITION OF GRAIN GROWN IN DIFFERENT LOCALITIES.

Name of Breed.	Origin.	Moisture.	Protein.	Ash.	Lime.	Magnesia.	Sulphuric Acid.	Phosphoric Acid.
		%	%	%	%	%	%	%
Hickory King.....	Richmond, Natal.....	8·57	9·71	1·26	Trace	*	0·06	0·60
Hickory King.....	Manderston, Natal.....	8·15	9·98	1·29	,,	*	0·05	0·62
Hickory King.....	Schapenrust, Transvaal.....	8·25	10·15	1·09	,,	0·19	0·04	0·51
Iowa Silver Mine.....	Potchefstroom.....	8·24	9·63	1·17	,,	0·21	0·02	0·50
Natal White Horsetooth	Richmond, Natal.....	9·08	9·36	1·20	,,	0·20	0·04	0·58
Golden Beauty.....	Richmond, Natal.....	9·04	9·98	1·22	,,	0·20	0·04	0·63
Yellow Horsetooth.....	Richmond, Natal.....	8·70	10·06	1·23	,,	0·22	0·02	0·57
German Yellow.....	Craigside, Natal.....	8·63	9·36	1·23	,,	0·19	0·03	0·62
Sheep's Tooth.....	Buffelspoort, Transvaal.....	8·41	10·06	1·29	,,	0·21	Trace	0·62
Chester County.....	Nancefield, Johannesburg...	8·08	8·58	0·94	,,	0·20	0·01	0·42
Eureka.....	Schapenrust, Transvaal.....	8·28	9·19	1·08	,,	0·20	0·06	0·47
Wills' Gehu.....	United States of America..	8·27	11·11	1·40	,,	0·27	0·04	0·69
Wills' Gehu.....	Schuurweberg, Pretoria.....	8·06	11·55	1·14	,,	0·23	0·03	0·52
Wills' Dakota.....	Schuurweberg, Pretoria.....	7·61	11·29	1·04	,,	0·19	0·05	0·45
Reid's Yellow Dent....	United States of America..	8·82	9·36	1·33	,,	0·22	0·01	0·64
Boone County.....	Umzinto, Natal.....	8·01	9·84	1·12	,,	0·20	0·02	0·48
Yellow Hogan.....	Vereeniging, Heidelberg....	8·19	9·71	1·24	,,	0·23	0·03	0·62
Chester County.....	Leeuwdoorns, Wolmaransstad.....	8·12	9·58	0·94	,,	0·19	0·02	0·39
"Argentine".....	Skinners Court, Pretoria...	7·98	8·23	1·42	,,	0·25	0·01	0·69
Cinquantino.....	France.....	8·05	12·95	1·48	,,	0·29	0·04	0·79
White Botman.....	Leeuwdoorns, Wolmaransstad.....	7·94	12·69	1·10	,,	0·23	0·01	0·44
Virginia Horsetooth....	Kameelsdrift, Pretoria.....	7·96	10·84	1·51	,,	0·22	0·02	0·67
Mealie-meal.....	Aliwal North, Cape Province	8·70	8·71	1·07	,,	0·20	0·02	0·49
White Cango.....	England ("Vryburg Dist.")	7·67	11·64	1·22	,,	0·23	0·03	0·56
Yellow Cango.....	England ("Vryburg Dist,")	7·55	10·76	1·04	,,	0·21	0·01	0·44
German Yellow.....	England ("Vryburg Dist.")	7·56	10·93	1·37	,,	0·23	0·04	0·51
Eureka.....	England ("Vryburg Dist.")	7·19	10·15	1·09	,,	0·25	0·02	0·63
Average of twenty-three South African grown samples		8·14	10·14	1·18	—	0·195	0·028	0·545
Average of the two American samples.....		8·54	10·23	1·36	—	0·24	0·025	0·665
Cinquantino, European grown.....		8·05	12·95	1·48	—	0·29	0·04	0·79

* Not determined.

TABLE NO. 4.—CHEMICAL COMPOSITION OF DIFFERENT VARIETIES OF AMERICAN-GROWN MAIZE.

	Water.	Ash.	Protein.	Crude Fibre.	Nitrogen-free Extract.	Fat.
Dent maize (average of 86 analyses).....	10·6	1·5	10·3	2·2	70·4	5·0
Flint maize (average of 68 analyses).....	11·3	1·4	10·5	1·7	70·1	5·0
Sweet maize (average of 28 analyses).....	8·8	1·9	11·6	2·8	66·8	8·1
Pop maize (average of 4 analyses).....	10·7	1·5	11·2	1·8	69·6	5·2
Flour maize (average of 5 analyses)...	9·3	1·6	11·4	2·0	70·2	5·5
Average of 208 analyses of all varieties.....	10·9	1·5	10·5	2·1	69·6	5·4

[*Quoted from J. Burtt-Davy's book on "Maize."*]

ANALYSES OF SOUTH AFRICAN GLUTEN-FEED AND OILCAKE MEAL.

	Gluten-feed.		Oilcake Meal.	
	Yellow Maize.	White Maize.	Yellow Maize.	White Maize.
Moisture.....	10·0	8·50	6·5	5·96
Ash.....	0·6	0·80	2·0	1·60
Protein.....	21·5	19·34	22·0	18·11
Fibre.....	6·0	7·76	9·0	13·56
Fat.....	3·5	4·02	10·5	9·62
Digestible carbohydrates...	58·4	59·58	50·0	51·15
	100·0	100·00	100·0	100·00

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CHAPTER XIII.

AN INDUSTRY IN VEGETABLE OILS FOR SOUTH AFRICA.

A COUNTRY in which the sun shines as brightly as it does in South Africa appeals to one as the home of a vegetable-oil industry. Animal oils and fats are a basic element in the industrial structure of any country. A whale-oil industry of considerable proportions already exists, and close attention is being devoted to the development of fisheries in South Africa. A survey of fisheries is being undertaken at present, and the results are decidedly encouraging. (This subject is dealt with in Chapter X.)

The first and foremost industry as an absorbent of crude oils and fats is that of soap manufacture. The soap industry is firmly established in South Africa; in fact, this is one of the few instances in which the country is self-supporting. As in other countries, a large proportion of the raw material for soap-making is derived from the abattoirs, but at the same time, oils such as peanut oil, soya-bean oil, maize oil, and cotton-seed oil are used. Edible oils are also produced from these sources. In all, there are some fifteen soap plants in operation in South Africa, the largest being that of Messrs. Lever Brothers (S.A.), Ltd., at Durban, who have an oil-expression plant and a hydrogenation plant for producing stearine from whale-oil. There is, in consequence, very small chance of expansion in the soap industry with the present market, but, on the other hand, this industry offers a large and steady demand for oils and fats, both vegetable and animal. In the field of edible and lubricating oils, however, the case is different, only two or three plants being engaged in this line. This is well illustrated by the data on South African imports appended to this chapter. Statistics of exports and production of vegetable oils and related products are also shown later.

An examination of statistics shows there are possibilities of expansion; and consideration here of the sources and possibilities of a number of oils, large quantities of which are at present imported, will provide a selection for final consideration of those oils which show the best chance of commercial success.

Castor-oil.

In many parts of South Africa the castor plant can be grown successfully. It is a sub-tropical plant, and therefore the warmer, low-lying districts are the most favourable for its cultivation. Above an altitude of 2,500 feet it is killed by frost or its maturation prevented by autumn cold.

In the Transvaal it is stated to be quite at home in the Waterberg, Pietersburg, Zoutpansberg, Lydenburg, and Barberton Districts. In all the coastal districts of Natal, Zululand, and the Cape it can be successfully grown.

The best kinds to sow are the small-seeded wild varieties, in particular the variety known as Madras. These should be replanted each year. On drier soils medium and large-seeded varieties such as *Ricinus lividus* and *R. zanzibarensis* var. *viridis* do well but should be treated as perennials.

Yield of Beans.—An average yield from the results of many tests is about 1 lb. of beans per tree, and a good average annual yield per acre over a period of years may be taken as 400 lb. beans per acre.

Insect and Fungoid Pests.

A certain fruit moth (*Ophuisa cotella*) has been found to do considerable damage to castor trees. This moth eats the leaves and sometimes the pods containing the beans. In large plantations spraying with paris green and lime or arsenite of soda and slaked lime is effective. In small plots hand-picking will handle the trouble.

Castor-oil rust and a borer known as castor-oil stem-worm are other pests. The latter attacks plants only in their second year, and then only cultivated plants.

It must be explained, however, such pests are common in South Africa, and the methods of dealing with them economically and successfully have been well worked out.

Uses of Castor Products.

To the layman the best-known property of castor-oil is its medicinal one; to the industrialist it is better known as a lubricant. Castor-oil has a lower viscosity temperature coefficient than mineral lubricants. With petrol engines, however, it produces excessive carbonization, though it is stated that this disadvantage does not appear in use with alcohol fuels. It is also used for making special soaps, in particular the transparent soaps.

The oilcake is a valuable manure. In addition to nitrogen, it contains up to 2 per cent. phosphoric acid and up to 1.5 per cent. potash. It contains, however, " ricin," which is toxic to cattle, and to render the cake suitable as feed, very thorough washing with salt solution is necessary.

South African castor beans were valued in 1914 (pre-war) at £11-£15 per long ton in London.

Conclusions.—It must be pointed out that castor-bean cultivation is not as remunerative as other agricultural crops, and at the same time it is inferior in this respect to other oil-bearing products. Very little market for the cake exists. The best districts for its cultivation are along the coast, especially on the Natal coast.

Maize Oil.

The question of this product is linked up with that of maize products generally, under which head it is treated. (See Chapter XII.)

Cotton-seed Oil.

Cotton-seed oil is at present being produced by several companies in South Africa. Considerable expansion in the cotton industry is, however, certain, and there will be a corresponding expansion in the ginning and oil-expression industry, which is already established in South Africa. (See statistics of production appended.)

Peanut Oil.

Peanuts or ground-nuts are already grown extensively in South Africa, principally in the low country of the Transvaal, Natal, Zululand, and Swaziland. Large quantities used to be imported from Portuguese East Africa, but each succeeding year the quantity is being reduced. There is no reason why the nuts should not be grown in the coastal districts, the oil expressed near or at the ports and shipped overseas in large quantities.

Most of the nuts are used for the manufacture of soap, and the expression of oil from the nuts is in the hands of the soap producers. The average oil-content of South African nuts is 48 per cent.

Yields per acre computed from statistics of agricultural production for 1920-21 were:—

Cape	340	lb. nuts per acre.
Natal	690	„ „
Transvaal	445	„ „

The following are results of tests of Rhodesian oils carried out at the Imperial Institute:—

Southern Rhodesia.

Sp. gr. 15·5° C./15·5° C.	0·916
Acid value	2·0
Saponification value	188·1
Iodine value	93·0

Valued at £40 per ton, London (October, 1905).

North-Western Rhodesia.

Sp. gr. 15·5 C./15·5° C.	0·919
Acid value	2·2
Saponification value	189·7
Iodine value	96·5

Valued at £38–£45 per ton, which was the current market price in London at that time (September, 1911).

Conclusions.—There is undoubtedly a field for ground-nut oil production when oils as good as the above can be produced in South Africa. The yields per acre given above indicate the Natal coast as a very favourable location from the point of view of low cost of production and also nearness to export markets.

Linseed.

The Union's importation, as shown in the complete table appended, is about 300,000 gallons per annum. The oil is used chiefly for the manufacture of paints and for medicinal purposes.

The flax plant is grown for two reasons: to produce fibre and for the oil-content of the seed. For fibre production a tall, straight stem and few branches are needed. This requires a temperate climate. (See Chapter XI on "Fibres.")

Flax for seed has been profitably grown in climates closely resembling that of certain parts of South Africa. In this case branches and flowers in plenty are desirable and are accompanied by a greater seed yield.

Some samples of Natal linseed sent to the Imperial Institute were stated to be of good quality and were valued in March, 1919, at £11 per ton.

Production of Linseed in South Africa.—As a result of experiments at Government farms, flax is grown fairly successfully, though so far in a small way only, in several districts of the Union, notably on the high veld, where there is a good summer rainfall. The average yield per acre is estimated at 200 lb., which is very low.

Sunflower Seed: "Helianthus annuus."

This is undoubtedly one of the oil-yielding plants of importance and worthy of consideration. It is, according to Wiley, of the United States Department of Agriculture, well suited to soils in which maize thrives. It is therefore certainly suited to many parts of a large maize-producing country like South Africa. It is easy to plant, cultivate, harvest, and handle by the same machinery as is used for maize, and, moreover, it forms a good rotation crop with maize. Its only disadvantage is that it impoverishes the soil in potash, but this can be partially overcome by feeding the stalks and other refuse to stock or by ploughing in the stalks or their ash. In 1920-21 there were about 10,000 acres under sunflower, mainly in the Transvaal.

From the industrial point of view, the seed is the important part of the plant.

The seed contains equal parts of husks and kernels. Removal of the husks, which are tough and fibrous and absorb oil, is necessary before expression. The kernel contains 36-53 per cent. of oil.

Removal of husks is best effected by kiln-drying to make them brittle and by subsequently running them between millstones. Cold and hot pressing in successive stages is the usual practice. The hot-pressed oil is clarified of precipitated inorganic matter by sedimentation or filtration.

The South African demand for sunflower oil is not large, and a market overseas would have to be found for this product. The cake is a valuable cattle-food and could be sold locally.

Results in South Africa.—From statistics for 1920-21 the following yields per acre have been computed:—

Natal	178	lb. seed per acre
Transvaal	371	„ „
Cape	330	„ „
Orange Free State	312	„ „

There is no doubt these yields could be raised by fertilization. In the two seasons, 1914-15 and 1915-16, the average yields of seed per acre obtained in experiments on fertilization conducted at the Government farm Gwebi, Rhodesia, are shown below:—

Fertilizer.	Yield, 1914–15 (lb. per acre).	Yield, 1915–16 (lb. per acre).
Unmanured	571	540
Kraal manure	649	960
100 lb. Safco Rhodesian maize fertilizer (composite fertilizer)	731	620
2,000 lb. lime	—	600

During the season 1915-16, 8 tons of kraal manure were applied per acre as against 7 tons in 1914-15.

The composite fertilizer had the following composition:—

	Per cent.
Phosphoric oxide soluble in water	12
Phosphoric oxide soluble in citrate solution, less phosphoric oxide soluble in water	1
Total phosphoric oxide	15
Nitrogen	2½
Potash	4½

South African seeds sent to London realized £28. 17s. per ton in 1916, but this price was abnormal and soon after fell to £22. In September, 1916, sunflower seeds in Johannesburg fetched 8s. 9d. to 9s. 6d. per 100 lb. The average wholesale market price runs about 9s. 5d. per 100 lb.

Conclusion.—Sunflower seed is undoubtedly one of the oil-producing materials worthy of consideration in South Africa. There is a small market for sunflower seed for chicken-feeding purposes, but this is not large enough to take into account. A yield per acre of 700 lb., if seed selection is practised, may be expected. The figures given above are obtained where the crop is grown merely for feeding purposes. Experiments have shown that the black seed, not the striped Russian variety, is most suited to South African conditions.

Sunflower-seed oil is used as an edible, like olive and other vegetable oils. It is also used for soap-making, and sometimes replaces linseed oil in paints.

Soya-bean Oil: "Glycine hispida."

This oil is one which has received a great deal of attention for a number of years in South Africa. Experiments have been conducted with a large number of varieties of the plant, and the results have indicated that most of them are suitable for cultivation in South Africa.

Source and Uses of Soya-bean Oil.—China is a very large producer and exporter of soya-bean oil. The beans are also grown in Ceylon. In 1910 the United Kingdom imported just over 420,000 tons of soya beans. This indicates the important position the material holds amongst the world's commercial products. In China the methods of expression are primitive, and any concern working on modern lines in South Africa should be able to compete successfully for a part of this trade; and there is cheap native labour in South Africa to be balanced against cheap Chinese coolie labour.

The oil is used in the East chiefly for food. The poor classes use either the crude oil or the hot-expressed oil. The latter is dark brown in contrast to the cold-expressed oil, which is white or light yellow.

So wide are its uses that no more can be done here than to quote the following table from the Farmers' Bulletin No. 973, United States Department of Agriculture:—

- Green manure.
- Forage.
- Pasture.
  - Hay.
  - Ensilage.
  - Soiling.
- Meal.
  - Human food.
    - Breakfast foods.
    - Diabetic foods.
    - Flour.
    - Infant foods.
    - Macaroni.
    - Crackers.
    - Milk.
      - Bread.
      - Cakes.
      - Muffins.
      - Biscuits.
  - Stock-feed.
  - Fertilizer.
- Oil.
  - Glycerine.
  - Explosives.
  - Enamels.
  - Varnish.
  - Food products.
    - Butter substitutes.
    - Lard substitutes.
    - Edible oils.
    - Salad oils.
  - Waterproof goods.
  - Linoleum.
  - Paints.
  - Soap stock.
    - Soft soaps.
    - Hard soaps.
  - Celluloid.
  - Rubber substitute.
  - Printing inks.
  - Lighting.
  - Lubricating.
- Food products.
  - Dried beans.
    - Soy sauce.
    - Boiled beans.
    - Baked beans.
    - Soups.
    - Coffee substitute.
    - Roasted beans.
    - Vegetable milk.
    - Breakfast foods.
    - Green vegetables.
    - Canned vegetables.
    - Salads.
  - Green beans.
    - Cheese.
      - Fresh.
      - Dried.
      - Smoked.
      - Fermented.
    - Condensed milk.
    - Fresh milk.
    - Confections.
    - Casein.

Conclusions.—Provided the bean is cultivated in a scientific manner, there should be every possibility of expressing the oil in South Africa and shipping it to Europe. The oilcake should find a good market in South Africa. The crop is valuable as a rotation crop with maize.

Miscellaneous Oils.

Candle-nut Oil.—Candle-nut oil has useful siccative properties, though in this respect it is inferior to linseed oil. It is derived from seeds of a tree called *Aleurites triloba*.

A sample of seed of South African origin showed these results:—

Ratio kernels to husks	35·1 : 64·9
Oil-content of kernels	65·6 %

The usual figure for the percentage of kernels varies between 36-43 per cent. Very little information is available on the distribution and occurrence of this material in South Africa.

Safflower Seed (Carthamus tinctorius).—This seed is cultivated in India and Egypt for its oil, though it yields a dye which is used in religious rites in the East. It has been tried out in Rhodesia, but no information is available.

Niger Seed.—Trials at Salisbury, Rhodesia, gave a yield of 1,400 lb. clean seed per acre. The seed usually contains 40-50 per cent. of oil. No experimental work on this material has been done in the Union.

The last three oil-bearing materials are mentioned more with a view to making the list complete than to recommend them to notice.

There are a number of other oil-producing plants in South Africa, but they are at present of little commercial importance. In most cases too little is known of their occurrence, though a number of samples have been analysed at the Imperial Institute. Of this class the Mafeura nut is the most important. Large quantities have been exported from Portuguese East Africa to Marseilles for soap-making. The plant grows wild in the north-eastern Transvaal, but the quantity available is unknown.

General Conclusions.

The oil materials worthy of notice and likely to be of commercial importance in South Africa are peanut or ground-nut, cotton-seed, maize, soya-bean, and possibly castor-bean.

For the manufacturer of vegetable oils there are two possibilities:—

(1) To grow the plant and express the oil.
(2) To buy the seed in the open market and express the oil.

It must, however, be emphasized that production on a large scale will necessitate building up an export trade in all cases.

ANALYSIS OF SOUTH AFRICAN CASTOR-OIL.

The following tables show a number of results of analyses of castor-oil from South African sources:—

	1.	2.	3.	4.	5.	6.	7.	Normal Values of Castor-oil.
Percentage of oil in whole seed	52·3	51·1	49·93	48·83	51·2	52·3	—	—
Percentage of oil in shelled husk	—	—	66·17	—	—	68·7	—	—
Percentage kernel	74·1	—	—	—	—	—	—	—
Percentage husk	25·9	—	—	—	—	—	—	—
Average weight of seed in grammes	0·581	—	—	—	—	—	—	—
Average number of seeds to 1 lb.	766	—	—	—	—	—	—	—
Specific gravity	—	—	—	—	0·963 (15·5/15·5°C.)	—	0·959 (15·5/15·5°C.)	0·960–0·967
Acid value	—	1·2	—	—	1·6	—	1·2	—
Acid value calculated as oleic acid	—	—	—	—	—	—	0·6%	—
Saponification value	—	—	—	—	183·0	—	179·6	175–183
Iodine value	—	—	—	—	90·0	—	87·0	84–85
Variety of seed	*R. communis lividus*	*R. sanguineus zanzibarensis*	Large-seeded red	Large-seeded red	*R. communis.*	Not given	—	—
Description of sample	—	—	—	—	Large bright brown seeds, with a copperlike and slight white markings	Clean, dark brown mottled seed, with a few black and white seeds	—	—
Where grown	Zoutpansberg	N. Rhodesia.	Near Johannesburg	Experiment Station	Rhodesia	Rhodesia	Rhodesia	—
Remarks	—	—	—	—	Oil completely extracted in two volumes 90% alcohol	—	Oil extracted locally dissolves in five parts 90% alcohol	—

Description of Seed.	Where Grown.	Yield of Oil.
		Per cent.
No. 8.—Large clean seeds—almost black.....	Salisbury	47·7
No. 9.— ,, ,, ,, black and white, striped...	,,	49·6
No. 10.— ,, ,, ,, light brown.....	,,	50·0
No. 11.—Smaller seeds—clean, mixed colour.....	,,	46·8
No. 12.—Large clean seeds—light grey or almost white.	,,	41·6
No. 13.— ,, ,, ,, brown, slightly pink.....	,,	50·0
No. 14.— ,, ,, ,, chocolate brown.....	,,	39·6
No. 15.—Medium-sized clean seeds—dark brown.....	,,	46·6
No. 16.....	Matabeleland	51·5
No. 17.....	N. Copper Co. Estates, N. Rhodesia	51·81

ANALYSES OF DIFFERENT VARIETIES OF SOYA BEANS.

Variety.	Where Grown.	Per-centage of Oil.
1. Mammoth.	Nottingham, Natal	18·57
2. Mammoth.	Umzinto, Natal	17·83
3. Not recorded.....	Barberton, Transvaal	17·43
4. Chinese White. ..	Cedara, Natal	16·88
5. Mammoth.....	Nelsrust.....	16·62
6. Southern.....	Transvaal(exact locality not stated)	—
7. Southern.....	Cedara.....	13·90
8. Not recorded.....	Skinner's Court	16·19
9. Southern.....	Skinner's Court	14·74
10. Black Soy.....	Skinner's Court	17·10
11. Early Okuti Manu Soy	Skinner's Court	15·27
12. Southern.....	Skinner's Court	16·25
13. Southern.....	Transvaal.....	17·82
14. Manchurian.....	Unknown.....	16·73
15. Manchurian.....	Unknown.....	14·67
16. Manchurian.....	Unknown.....	17·17
17. Manchurian.....	Unknown.....	14·86
18. Sakura.....	Unknown.....	17·89
19. Southern.	Unknown.....	19·99
20. Southern.....	Unknown.....	19·37
21. Southern.....	Tzaneen.....	17·59
22. Southern.....	Skinner's Court	19·25
23. Southern.....	High Veld (exact locality not stated)	—
24. Sakura.....	Kroonstad.....	14·98
25. Large White (Chinese White)	Swellendam....	18·78
26. Small Black.....	Swellendam....	17·43
27. Imported Manchurian	Winterton (3,354 ft.)	20·65
28. Imported Manchurian	Umtwalumi (49 ft.)	22·19
29. Imported Manchurian	Zululand (500ft)	21·36
30. Imported Manchurian	Batstones (3,600 ft.)	20·59

The oil yield varies with the variety of the seed and the conditions of growth. A tropical climate and heavy rainfall seem to give a decided increase in oil yield.

No complete analyses of the oil from South African grown beans are available, but the percentage of fatty acids in some samples are shown below. The same figure for a Manchurian and a Gold Coast oil is given for comparison:—

Where Grown.	Variety.	Percentage of Free Fatty Acid.
Nottingham.....	Mammoth....	1·62
Umzinto.....	Mammoth....	1·25
Barberton.....	Unknown.....	2·57
Cedara.....	Mammoth....	2·63
Cedara.....	Mammoth. .	2·75
Manchuria.....	Sakura.....	3·00
Gold Coast.....	Sakura.....	3·50

ANALYSES OF SOUTH AFRICAN FEEDING CAKES.

	Soya-bean Cake.	Ground-nut Cake (Nutted).	Cotton-seed Meal.	Linseed Cake.	Sesame Cake.	Palm-kernel Cake.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Protein	44·23	43·50	31·50	25·37	35·64	12·84
Fat	6·18	8·50	38·86	8·74	11·71	6·12
Crude fibre	5·82	4·50	3·88	2·91	1·35	4·98
Water	13·69	12·00	6·88	—	—	—
Carbohydrates	23·98	23·63	14·40	27·72	12·32	37·30
Ash	6·10	5·50	4·48	—	—	—

IMPORTS OF OILS.

	1926.		1924.		1922.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imports.	Gallons.	£	Gallons.	£	Gallons.	£
Food oils—						
Salad oil—						
Cotton-seed	6,670	1,213	6,532	1,063	7,036	2,091
Olive and Lucca	27,798	11,536	20,257	8,570	15,239	8,131
All other	304,939	71,865	370,512	81,386	202,011	46,515
Non-food oils—						
Castor-oil	44,270	15,825	36,951	17,580	62,329	18,561
Coconut oil	23,454	3,996	8,312	2,981	264,083	43,638
Cotton-seed	175	55	878	252	18,685	3,046
Essential and perfumed	35,849	—	—	23,375	—	19,454
Linseed oil	450,164	77,197	380,345	74,181	308,803	58,177
Palm and palm kernel	491	89	440	70	25,851	4,207
Other vegetable oils, N.O.D.	69,533	9,940	44,241	6,288	36,071	6,014

IMPORTS OF OIL SEEDS, NUTS, ETC.

	Quantity.	Value.
	lb.	£
1926	9,219,172	99,350
1924	5,336,134	39,298
1923	4,279,546	37,434
1922	3,340,314	28,491

IMPORTS OF MARGARINE.

	1926.		1924.		1922.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imports.	lb.	£	lb.	£	lb.	£
United Kingdom	201,996	6,656	444,451	16,185	298,746	10,624
Holland	93,040	2,880	218,446	6,747	83,234	2,615
Norway	5,849	229	—	—	1,120	50
United States of America	81	3	115	9	—	—
Other Countries	4,796	421	—	—	84	2
TOTAL	305,762	10,189	663,012	22,941	383,184	13,291

IMPORTS AND EXPORTS OF SOAP.

	1926.		1924.		1922.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imports.	lb.	£	lb.	£	lb.	£
Common brown	1,505,309	24,793	1,701,788	25,991	1,148,557	19,446
Toilet	776,759	58,197	508,313	53,007	301,557	36,826
Extract and powders	227,407	5,658	172,175	4,004	169,504	4,138
Exports (South African produce)						
Common	52,959	1,468	162,565	4,162	158,964	4,713
Toilet	12,552	563	8,498	625	14,196	1,100

IMPORTS OF GLYCERINE.

	1926.		1924.		1922.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imports.	lb.	£	lb.	£	lb.	£
Distilled glycerine	44,255	1,841	4,887	298	841	100
Glycerine for manufacturing purposes—						
Crude	6,332,957	189,690	4,894,507	109,634	2,330,193	78,285
Other	425,115	12,613	6,402,150	186,903	1,908,840	64,576

SOAP AND CANDLE FACTORIES.

Quantity and Value of Materials Used, 1922–23.

	Quantity.	Value.
	lb.	£
Tallow	11,191,068	207,983
Oils	9,718,460	166,280
Fats	4,716,568	79,905
Dyes	38,117	2,937
Perfumery	—	12,103
Chemicals	—	56,494
Stearine	1,580,333	41,419
Paraffin wax	18,515,979	247,392
Candle-wick	92,897	14,695
Other materials	—	35,822
Packing Materials	—	147,601
Total value (cost) of materials used	—	1,037,248
Value of South African materials used	—	279,465
Value of imported materials used	—	757,783
Resin	2,543,398	24,617

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CHAPTER XIV.

TEXTILE INDUSTRIES.

SOUTH AFRICAN wool is too well-known to require any long historical or descriptive introduction. The annual wool clip is in the neighbourhood of 125,000,000 lb.

Cotton-growing has also expanded rapidly during recent years. Early attempts to cultivate cotton failed, and the present successful development dates back only as far as 1910, when the British Government and the cotton manufacturers of England held out inducements to cotton growers throughout the Empire. Cotton from the agricultural point of view is treated fully in the booklet, "Farming Opportunities in South Africa."

The textile industry in South Africa is capable of being developed to a great extent, and will in time prove of importance to the country.

The abnormal conditions brought about by the war, the enormous increase in cost of freight, and the higher rate of wages caused by labour trouble overseas, have given South Africa a unique opportunity of establishing a woollen industry on a sound basis.

A factory known as the Woollen Mills, Ltd., was opened some years ago, with branches and woolwasheries at Woodstock, Capetown, and at Wolseley, C.P. This is the pioneer textile factory of the Union. "Waverley" blankets, travelling rugs, tweeds, and blankets for the native trade are manufactured.

Almost the whole of the Union wool clip has hitherto been shipped overseas, there to be manufactured into goods which are bought back by South Africa. The production in South Africa is steadily increasing. For instance, the clip of 1921 exceeded that of 1920 by 9.3 per cent. This is accounted for by the increase in the number of sheep, and also by improvement in the class of sheep, due to the efforts of the Sheep Division of the Department of Agriculture in assisting farmers to classify and grade their flocks.

The appended tables give data on the total production, exports, and imports of South Africa for the years 1923 and 1924. Statistics relative to the wool washeries in operation in the Union are also given.

There are, it is plain, very good possibilities of development in the manufacture of woollen goods.

Cotton.

Cotton-growing has now got beyond the experimental stage in many districts of the Union, and promises to become one of the staple crops in certain areas. This is important, as in South Africa there is a large demand for cheap cotton goods. With the native population of between five and six millions, this class of goods finds a ready market.

The areas at present under cultivation are situated in the districts of the northern and eastern Transvaal, Swaziland, Zululand, and Natal; the most important among these being the Candover Cotton Estates, Natal, and the Rustenburg District of the Transvaal. Producers are represented by:

The Rustenburg Farmers' Co-operative Society, Rustenburg;

The S.A. Co-operative Cotton Growers, Ltd., Box 1423, Durban.

An attempt is being made by the Division of Tobacco and Cotton of the Department of Agriculture to encourage farmers in the eastern Cape Province and the Transkei to start

cotton-growing in those districts, where up to the present operations have been merely on an experimental scale.

It will be seen from the appended statistics of imports and exports that cotton manufactures to the value, roughly, of from five to seven million pounds are imported yearly into the Union.

In view of the fact that the climate in many parts of the Union is suitable to the cultivation of cotton and that a great increase in the annual production of cotton within the next few years is certain, there is every reason why a large proportion of the goods now imported into South Africa should be manufactured here.

It must be kept in mind, however, that all machinery and dyes used in this industry would have to be imported. Further, a considerable staff of skilled and experienced operators would be required to serve as a nucleus to locally recruited white, coloured, and native labour.

Plants for the manufacture of cotton goods could be set up in the same centres as the ginneries. There is no lack of market, especially for the cheaper class of goods for the native trade.

At the same time, the facts that there are such large imports and that raw cotton is available in plenty, point to success in this branch of industry.

PRODUCTION OF WOOL.

Year.	Cape.	Natal.	Transvaal.	Orange Free State.	Native Reserves, etc.	Total.
	lb.	lb.	lb.	lb.	lb.	lb.
1921-22....	64,080,370	5,504,460	15,113,570	47,600,360	7,754,189	140,052,949
1922-23....	62,820,935	5,459,462	15,245,466	44,095,297	9,596,425	137,217,585
1923-24....	67,095,122	6,023,830	15,888,992	47,796,015	11,061,534	147,865,493

IMPORTS OF WOOLLEN MANUFACTURES.

	1923.	1924.
	£	£
Cloth and Piece Goods...	774,447	813,510
Blankets and Rugs.....	344,239	445,496
Shawls and Shawling....	57,836	78,649
Hosiery (underclothing)..	200,379	200,266
All other N.O.D.....	221,202	258,675

EXPORTS OF WOOL AND WOOLLEN MANUFACTURES (SOUTH AFRICAN).

	1923.		1924.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	lb.	£
Sheep's Wool—				
Scoured.....	8,665,616	1,213,553	8,553,777	1,534,761
In the grease.....	155,735,351	11,160,188	166,041,376	14,229,192
Washed.....	86,611	14,445	—	—
Piece goods.....	—	3,241	—	6,414
Blankets and rugs.....	—	4,469	—	483
All others N.O.D.....	—	214	—	179

STATISTICS OF WOOL WASHERIES.

	No. of Factories.	Value of Materials Used.	Valued Output.
		£	£
1921–22.....	14	37,502	156,907
1922–23.....	12	24,812	115,224

MATERIALS USED, 1922–23.

	Quantity.	Value.
Soap—	lb.	£
South African.....	249,993	6,605
Imported.....	629,401	9,163
Alkali.....	—	3,831
Other scouring materials.	—	1,346
Packing materials.....	—	3,867

COTTON MANUFACTURES.

Imports.

	1924.	1923.
	Value. £	Value. £
Piece goods.....	3,979,606	4,140,754
Blankets and rugs.....	810,551	744,143
Shawls and shawling.....	105,678	76,632
Hosiery (underclothing)..	1,058,021	1,147,287
Waste.....	42,242	26,877
Wick.....	13,382	17,478
Other manufactures N.O.D.	307,117	816,453

Exports.

South African Produce.	1923.	
	Quantity.	Value.
		£
Piece goods.....	Nil.	Nil.
Blankets and rugs.....	—	—
Hosiery and underclothing	—	18
Shawls.....	Nil.	Nil
All other manufactures...	Nil.	30

South African Produce.	1924.	
	Quantity.	Value.
		£
Piece goods.....	Nil.	Nil.
Blankets and rugs.....	—	15
Hosiery and underclothing	—	—
Shawls.....	—	—
All other manufactures..	—	—

EXPORTS OF RAW COTTON.

1924: 3,299,388 lb.; Value £170,781.
1923: 2,585,622 lb.; Value £123,696.

ESTIMATED PRODUCTION.

1923: 7,346,710 lb.
1924: 10,003,285 lb.

CHAPTER XV.

LEATHER AND LEATHERWARE INDUSTRIES.

THE boot and shoe and tanning industries have developed considerably in South Africa during and since the war, as has also the manufacture of bags and trunks. There is still considerable room for expansion in all these industries, particularly in the manufacture of light leathers, which has not kept pace with the demand caused by the expansion of the footwear industry.

The total annual value of imports of leather and leather goods is about £1,494,000; of this £1,002,000 is in boots and shoes, £300,000 in light leathers, and £37,000 in light leather goods, such as gloves and mittens.

South Africa is a very large producer and exporter of hides and skins of good quality, and exported over £3,000,000 worth in 1924. It is only in recent years, however, that these materials have been utilized locally for the production of manufactured leather goods. A good class of shoe is being made and sold successfully.

A great deal of development has taken place in the production of light chrome kips, goatskins in morocco and glacé, but there are great possibilities of expansion in these lines and also in higher grade calf and kid leathers.

The statistics given indicate the expansion which has taken place and the possibilities of further expansion in all branches of the leather goods industries.

Materials.—The materials required are—

(1) Hides and skins.
(2) Chemicals.

Hides and Skins.

Hides and skins for making leather of all kinds are obtainable in South Africa. Hides are prepared and placed on the markets in the following classes:—

(*a*) *Market or Blood Hides.*—These are freshly slaughtered hides, drained, and offered for sale, and naturally cannot be kept long in this condition.

(*b*) *Wet Salt Hides.*—These are cured for storage by plunging into a brine bath, or heavily salting in a pile.

(*c*) *Dry Salt Hides.*—These are preserved as in (*b*), and then dried out.

(*d*) *Sun-dried or Flint Hides.*—These are cured by being dried in air, without any preservative.

(*e*) *Arsenicated Hides.*—Cured by plastering the flesh side with alkali earths and drying out.

Chemicals and Tanning Materials.

Most of the chemicals required are available in South Africa, though some are entirely imported products. Vegetable tan is available in the form of wattle bark or wattle extract. This product is well known in commerce, and need not be discussed here. The average market price of tan bark can be taken as about £8 per ton of 2,000 lb. and that of the extract about £18 per ton f.o.r. Durban or Pietermaritzburg. The percentage of tannin in the bark is about 13.

Mineral tans are all imported into South Africa. Recently a lot of attention has been devoted to the chromium ores, which occur in the eastern Transvaal and Rhodesia. It would, of course, be uneconomical for a tannery to make its own chromium tans, but developments may take place, at any time, which will make these materials available on the South African market and do away with the necessity to import.

Lime, salt, caustic soda and soda ash, and hydrochloric acid, are obtainable from South African sources, but dyes and tanning materials other than those derived from wattle it would be necessary to import.

At present only the higher grades of light leathers, i.e. glacé kids, calf leathers, suèdes, etc., are imported under the *Free List* for *English Manufactures*. There is a large scope in these lighter leathers for development and progress.

The manufacture of gloves and other light leather goods is a branch which should be represented as quite open to enterprise. As shown in the statistics, about £22,000 worth of gloves and mittens are imported annually.

Suitability of South African Hides.

With regard to the suitability of South African hides and skins for the various classes of leather, the following facts are interesting.

Sole leather is required to be heavy, plump, and well grown. South African hides, being by their nature thick and plump (i.e. of greater density), are much more suitable for sole leather than the thin, spready Australian hide.

For harness and upper leather, on the other hand, Australian hides are more suitable than South African.

As regards skins, nothing in the world, except perhaps the Scotch skin, can beat the pure Cape skin for texture and strength, and it is eminently suitable for making gloves and other light leather articles.

As a rule South African hides and skins are, as regards their natural qualities, quite as good as those from any other part of the world, but greater care needs to be devoted to the flaying and branding than is generally used.

A summary of important points relative to this question is given:—

(*a*) There is a great world demand for the raw products—that is, hides and skins.

(*b*) There is a shortage in South Africa of manufactured leather.

(*c*) This shortage will be beneficial to the development of the manufactured article, as it will cause a demand for South African manufactured leather, and will prove that good South African leather can be obtained. On the other hand, the defects before mentioned, i.e. bad flaying, scratches, and brands, militate against the South African tanner being able to make the finer classes of leather, but a demand for hides and skins free from defects would lead to a better practice.

Economically speaking, the possibilities of development and expansion in the manufacture of boots and shoes and other leather goods are bright.

It was impossible to keep up the supply of labour during the war, but since 1919 many skilled and technical men have been brought out to the factories and the quality of goods produced was raised to a much higher plane. There are, however, good opportunities for the introduction of highly skilled and up-to-date technical men.

IMPORTS OF LEATHER AND LEATHER GOODS.

	1922.		1923.		1924.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	lb.	£	lb.	£	lb.	£
Enamelled, morocco, and patent in the piece.	24,247	10,314	41,631	15,747	46,319	19,438
Pigskin in the piece	4,320	1,365	7,763	2,439	9,808	2,236
Other kinds in the piece	787,663	158,684	1,309,125	198,192	548,020	86,250
Hide, valve	1,426	234	5,898	963	2,848	531
Bags and trunks	—	23,938	—	25,854	—	28,571
	Pairs.		Pairs.		Pairs.	
Boots and shoes (men)	376,433	291,238	593,833	378,813	466,964	300,296
Boots and shoes (women)	1,044,521	654,099	1,128,191	602,601	1,213,886	631,109
Boots and shoes (children)	269,437	87,864	226,543	64,498	242,309	63,580
Slippers	252,142	39,294	283,963	43,630	139,691	24,266
Saddlery and harness	—	22,877	—	45,093	—	52,006
Manufactures N.O.D.	—	64,888	—	72,141	—	71,262
Gloves and mittens	—	23,731	—	17,756	—	21,807

EXPORTS OF LEATHER AND LEATHER GOODS.
(South African Produce.)

These exports were chiefly to South African territories, but small quantities were shipped to the United Kingdom.

	1922.		1923.		1924.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pairs.	£	Pairs.	£	Pairs.	£
Boots and shoes	3,028	2,241	1,373	1,221	1,693	1,048
Saddlery and harness	—	512	—	365	—	418
	lb.		lb.		lb.	
Unmanufactured leather	18,391	2,082	5,688	646	27,668	2,718
Manufactures N.O.D.	—	1,310	—	1,293	—	365

IMPORTS AND EXPORTS OF HIDES AND SKINS.

	1922.		1923.		1924.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imports—	lb.	£	lb.	£	lb.	£
Hides (ox and cow)	120,427	5,037	271,342	8,121	296,042	7,508
Skins (sheep and goat)	32,018	1,123	29,172	992	66,291	2,460
All other kinds	—	492	—	246	—	1,024
Exports—						
Hides (ox and cow), dry	10,013,328	283,269	11,758,062	369,223	19,720,185	669,858
Hides (ox and cow), wet	8,021,900	193,122	9,010,210	230,086	11,719,534	302,865
Goat skins	6,287,205	216,879	6,601,052	266,243	7,724,180	329,210
Seal skins	146,746	14,034	115,656	14,507	132,130	17,456
Sheep skins (Cape)	9,034,270	359,145	7,422,548	416,838	9,224,861	558,797
Sheep skins (Merino)	29,954,930	878,683	24,673,792	1,176,124	20,302,570	1,298,382
Wild animal	—	7,669	—	10,095	—	17,780
All other	—	374	—	2,730	—	2,611

BOOT AND SHOE FACTORIES AND REPAIRING ESTABLISHMENTS.

Quantity and value of materials used.
(1922–23.)

	Quantity.	Value.
		£
Leather (South African)..... lb.	4,759,401	371,073
Leather (imported)..... ,,	93,974	10,032
Leather (South African)..... sq. feet	2,518,051	116,512
Leather (imported)..... ,, ,,	1,996,178	149,461
Uppers and cut soles purchased—		
South African.....	—	5,110
Imported.....	—	5,254
Thread, etc.....	—	95,103
Stains and polish.....	—	6,620
Other materials.....	—	13,517
Packing material.....	—	28,948
Total value of all materials used.....	—	801,630
Value of South African materials used.....	—	507,508
Value of vegetable-tanned leather.....	—	432,310
Value of chrome-tanned leather.....	—	215,618

TANNERIES.

(1922–23.)

(i) Materials used.

	Quantity.	Value.
		£
Hides..... tons (2,000 lb.)	5,851	344,060
Skins—		
Sheep..... No.	66,704	6,046
Goat..... ,,	68,597	12,410
Other..... ,,	11,704	1,419
Wattle-bark..... tons	4,390	28,515
Wattle-bark extract.....	—	4,968
Other vegetable-tanning materials.....	—	33,802
Mineral-tanning materials.....	—	16,691
Lime and other materials used in process of liming.....	—	5,805
Oil, fat, tallow, and other stuffing materials.....	—	13,231
Dyeing materials.....	—	6,857
Other materials (including packing materials).....	—	9,334
Total value (cost) of materials used.....	—	483,138
Value of South African materials used.....	—	411,529
Value of imported materials used.....	—	71,609

(ii) Articles Manufactured or Produced.—1922–23.

	Quantity.	Value.
		£
Leather, sole—		
Vegetable-tanned	lb. 4,873,152	370,401
Chrome-tanned	,, 553,280	66,271
Leather, upper—		
Vegetable-tanned	,, 717,965	85,688
Chrome-tanned	,, 675,433	108,439
Leather harness (including straps, bridle, rein, saddle, skirt, and other leather used in the manufacture of harness, saddlery, suitcases, bags, etc.)	,, 556,047	62,243
Leather, other	,, 98,569	7,716
Skins	No. 83,527	30,025
Wool and hair	—	992
Other articles manufactured or work done	—	6,606
Total value of articles manufactured or produced	—	738,381
Total value of vegetable-tanned leather produced	—	525,306
Total value of chrome-tanned leather produced	—	175,452

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CHAPTER XVI.

THE CERAMIC, GLASS, AND CEMENT INDUSTRIES.*

THE Union's ceramic industry has expanded quite rapidly of recent years, and this applies also to the cement industry. The attempt to build up a glass industry has also at last met with success.

Complete statistics of imports, exports, and production are appended to this article. They illustrate the expansion that has taken place in the manufacture of ceramic wares and cement. At the same time they show by the large volume of imports that there is still a wide field for development in the ceramic industry. The cement industry is likely soon to be in a position to supply all South African needs, and possibly an export trade will be built up. The glass industry, as indicated, presents an open field.

The Ceramic Industry.

Excluding porous unglazed ware made by the natives, one would naturally expect building bricks to be the first ceramic product in South Africa.

At present excellent bricks are made in Maritzburg and Durban, Pretoria and other Transvaal centres, at Heidelberg, Kimberley, and Bloemfontein, and other Orange Free State and Cape Province centres. In some cases continuous kilns and up-to-date machinery are in operation.

The manufacture of roofing tiles has made great strides in the last few years owing to the abnormal price of imported corrugated iron. Tiles have become the chief roofing material in most South African inland towns. South African tiles are equal in every respect to the best grades made in Europe.

Fireclay and *Firebricks* are prepared in large quantities. The quality is excellent, and a good market is found for these products on the Rand mines. All refractory materials for use in ordinary furnace work, such as the carbonization of coal, are obtainable in South Africa. The centres of this branch of the ceramic industry are Vereeniging, Olifantsfontein, and Boksburg, all within fifty miles of Johannesburg by rail. At these three centres, stoneware, chemical stoneware, crucibles, refractory wares as already mentioned, and silica and magnesite bricks, all with an established reputation, are produced. The Consolidated Rand Brick, Pottery and Lime Co. proposes to take up the manufacture of glazed lavatory basins and water-closet fittings, and it is probable that Olifantsfontein clay, with felspar from the Leydsdorp district, will be employed in this work.

There is, however, quite a large untouched field in ceramic wares, as well as room for expansion in the lines already mentioned. This is quite evident from the import statistics appended. Electrical fittings and sanitary wares having an earthenware or fireclay base could be made. In smaller lines, such as teapots, household ware, brown glazed ware, bowls, etc., vases and plant pots, there are chances for development. Suitable clays abound in various parts of South Africa.

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* Compiled from reports by Dr. P. A. Wagner, Union Geological Survey, and John Adams, A.R.C.S.

Materials.

The materials for pottery obtainable in the Union are china-clay, ball-clay, quartz, fireclay, and various red and other common clays and shales.

China-clay, or kaolin, is found in various parts of South Africa, usually impregnated with a large percentage of iron, though often quite pure. The factory at Olifantsfontein used a clay from Krugersdorp, and another variety from near Capetown which fired quite white, and these fulfilled their purpose very well. The properties of kaolin are: slight plasticity, infusible, medium contraction in firing, and when fired the colour is white to cream. Professor Schwarz, of Grahamstown, states that he has taken specimens of absolutely pure kaolin from the Upper Witteberg rocks near Grahamstown. A deposit of very clean pure kaolin occurs at White River, Transvaal. Some of the clay found on the Cape Flats seems to be quite white, but so far the material has been very difficult to use on account of its excessive shrinkage. Kaolin of good quality is found near Steinkopf, in Little Namaqualand, but the deposit is at present too inaccessible to allow the material to be utilized.

Ball-clay is a vitrifiable clay, colour usually grey-blue to black, and it contains a higher percentage of fluxes than kaolin. Its properties are: extreme plasticity, vitreous, high contraction in firing, and when fired the colour is yellowish. No clays have been discovered in South Africa which closely resemble the English ball-clays from Devon and Dorset. The blue clay found in the Olifantsfontein clay pits is the nearest that has been tested yet, and on the whole it produces good results. The discovery of a supply of ball-clay would be of considerable value to South African potters.

Quartz, very white and free from iron, is obtained from a huge vein of pure quartz in the grounds of the Modderfontein Dynamite Factory, and similar deposits are frequent in all granite areas. This excellent material has been used with success in bodies and glazes for tiles and earthenware, and also for silica bricks. Accessible deposits of quartz occur in many parts of the Transvaal.

Gypsum, for the manufacture of plaster of paris, is being mined in the valley of the Tugela, Natal, in the Boshof District of the Orange Free State, and near Kimberley. It also occurs frequently in pans in Griqualand West and on the coast of Namaqualand.

Fireclays, especially those of the Transvaal, are frequently of excellent quality, and have proved in certain deposits to be equal to the famous fireclays of Glenboig and Stourbridge. Those in the Transvaal are used in the manufacture of firebricks and fireclay goods of all kinds. The quality of a clay cannot be decided by its analysis alone. The following figures, however, are of interest:—

ANALYSES OF TRANSVAAL FIRECLAYS.

Boksburg.

	By the East Rand Proprietary Mines, Ltd.	By Sidney Billbrough & Co.	
Silica (combined)	52·58	48·40	44·70
Alumina	32·70	37·00	41·60
Ferric oxide	0·87	1·00	0·40
Lime	0·26	—	—
Magnesia	0·53	trace	trace
Alkalies	0·26	—	—
SO_3	—	—	—
Loss on calcination	12·80	14·30	14·40

Olifantsfontein.

	By Dr. P. A. Wagner.		
Silica (combined)	43·64	45·46	45·19
Alumina	39·16	38·36	38·73
Ferric oxide	1·53	1·87	0·52
Lime	0·30	0·00	0·26
Magnesia	0·34	0·27	0·22
Alkalies	0·47	0·31	0·94
SO_3	1·00	0·39	0·01
Loss on calcination	13·56	13·34	14·07

The proportion of silica, alumina, and water in the pure clay molecule are:—

Silica	46·64	per cent.
Alumina	39·45	,,
Water	13·91	,,

It will be seen that several of the Transvaal clays approximate closely to the composition given above.

Regarding the Vereeniging fireclays, samples were submitted to the Leeds Fireclay Co., England, for investigation, in 1913, and the following report was returned:—

"*Surface Fireclay.*"—It is free from soluble salts. It possesses moderate plasticity of about the same degree as is possessed by an average sample of Leeds fireclay. After being pugged and allowed to dry, the resulting mass is hard and tough, and of good tensile strength. The clay is quite free from lime compounds, which are often present in buff-burning clays. Calcined at Seger Cone 9 (1280° C.), the result is a clean buff porous mass, which is free from concretionary impurities. The refractoriness corresponds to Seger Cone 32 (1710° C.), which is equal to the best Leeds or Stourbridge fireclays.

In Natal, grey shales somewhat lacking in plasticity are found at Hilton Road, Natal, and in the neighbourhood of Gezubuso, on the East Griqualand line.

Excellent *Common Red* and *Yellow Clays* and shales are widely distributed over the country, and in certain districts are utilized in the manufacture of bricks, roofing and paving tiles, drain-pipes, architectural ornaments, etc. Generally speaking, little has been done with them up to the present, and their properties are not very well known. Besides, in the clay-working industries they are used at many places for making paint and distemper, and in various other ways.

The Uitenhage formation contains much clay in the region between Algoa Bay and the mountains near Uitenhage. The same formation in the country between Mossel Bay and Heidelberg has a large amount of clay in it. The beds vary in quality, and there is generally a fair amount of grey, blue, or red colouring matter in them. In the Somerset West District, fine grades of clay have been obtained. Bricks have been made extensively from the clay worked on the Cape Flats, and at Grahamstown, bricks, tiles, and other objects have been produced.

Analyses of Clays formerly worked by the Marseilles Tile and Pottery Co (S.A.). Ltd.:—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Natural colour	red	blue	white	cream	yellow	terra-cotta
Fired colour	red	white	white	cream	red	red
Moisture	5·47	5·45	1·34	3·15	2·27	6·25
Loss on heating	5·30	5·56	3·07	4·42	3·96	4·91
Silica	58·00	66·18	78·64	66·00	67·05	68·38
Oxide of iron	8·25	trace	trace	trace	6·23	13·75
Alumina	19·80	26·32	16·52	23·87	18·00	5·82
Lime	0·22	0·20	0·07	0·32	0·20	0·10
Magnesia	0·95	0·53	0·11	0·52	0·77	0·28
Undetermined alkalies, etc.	2·01	1·76	0·25	1·72	1·53	0·11

(Analyses by E. V. Flack, Government Analyst.)

In Natal the best known deposit is that in the Maritzburg valley, from which excellent bricks and roofing tiles are made, and the shales at Umgeni, near Durban, are also utilized for the same purpose.

There are many useful clays between Sarnia and Drummond, on the Durban-Maritzburg line, and good clays are also to be found at Avoca Valley and Balgowan, between Maritzburg and Ladysmith.

In the Transvaal, bricks of excellent quality are made at Pretoria, Johannesburg, Turffontein, Olifantsfontein, and other localities. The well-known bricks from the Kirkness brickyard, near Pretoria, are made of a mixture of crushed Timeball Hill shale and a small portion of dark clayey loam occurring in an old channel of the Aapies River. Roofing and flooring tiles and terra-cotta ware are made at Pretoria, Turffontein, Olifantsfontein, and Vereniging of local clays. It is of interest to record that the large Italian tiles with which the Union Buildings at Pretoria are roofed were made at Vereeniging, as were also the fine garden vases designed by Mr. Herbert Baker and used in the grounds.

Felspar is obtainable in many localities in South Africa. Soda felspar is very plentiful, more so than potash felspar; but there is no apparent reason why the former cannot be used for most purposes in place of the latter. Felspar is found more especially in the corundum mines, where it forms the matrix of the rock in which the corundum crystals occur. It also occurs in large quantities near the railway at Mica Siding, Transvaal, but this deposit is not at present worked.

Pegmatite occurs frequently in the Union, but none has yet been found sufficiently pure to use in the manufacture of pottery, most of the samples fusing to a black mass. The manager of the Olifantsfontein works recently tested a sample of pegmatite which was good in colour but deficient in fluxes. A soft greyish-white rock, described as china-stone, occurs in the Transvaal at Benoni, near Johannesburg. It has been tested, with fair results.

Glass.

Sand.—No systematic work has hitherto been undertaken on South African sands suitable for glass-making. Investigations have been confined to such occurrences as are likely to be drawn upon in the near future. Enough, however, is by this time known to warrant the assertion that there are in the Union vast resources of sands suitable for the manufacture of all but the very finest grades of glassware. Only a few localities need be enumerated:—

Transvaal: *Pienaarspoort, Pretoria District.*—The deposit near Pienaarspoort in the Magaliesberg, was the source of the sand used by the Hatherley Glass Factory, mentioned later.

It is situated about 400 yards to the north-east of Pienaarspoort Siding, on the Pretoria-Delagoa Bay railway, by which it is traversed. The deposit appears to be of considerable extent, and boreholes have proved the sand to be 90 feet in thickness. Sections exposed in the main pit show from 1 ft. to 2 ft. of dark-grey sandy loam overlying the bed of glass sand, the maximum exposed thickness of which is 2 ft. 6 in. In some parts of the pit a layer of impure, brownish-grey sand intervenes between the sandy loam and the glass sand.

The latter is of pale yellowish white colour, except when traversed by plant rootlets, around which a concentration of reddish-brown ferruginous matter has taken place. It appears to be very uniform in character, though the composition probably varies somewhat from point to point.

The following analysis may be taken to represent the best material:—

	Unwashed Sand.	Washed Sand.
SiO_2	98·98	99·46
Al_2O_3	0·57	—
Fe_2O_3	·10	0·08
CaO	none	—
MgO	trace	—
Loss on ignition	0·31	0·20

The results prove the sand to be fairly pure, the iron-content being well within the limits prescribed for even the better grades of white glass.

Mineralogical Composition.—Under the microscope, the sand is seen to be composed almost entirely of grains of quartz, with very occasional turbid grains of felspar. Most of the grains are coated wholly or in part with thin films of ferruginous, clayey matter, which can be partially removed by washing the sand with water, and completely removed by treating it with hot hydrochloric acid. As regards the shape of the grains, there appears to be a close relationship between the degree of rounding and diameter, the very fine particles being almost without exception angular, those of medium grain sub-angular, and the coarse particles fairly well rounded.

A test of a representative sample of the sand with a solution of methylene iodide (sp. gr. 3.3) shows that it contains only 0.068 per cent. of heavy minerals, i.e. minerals of sp. gr. >3.3. This is below the average for ordinary glass sands. Magnetic particles constitute 28 per cent. of the concentrate. The remainder was found to be made up of a very interesting assemblage of minerals, including zircon, rutile, ilmenite, anatase, cyanite, and limonite. The ilmenite shows alteration to leucoxene. Zircon occurs in well-formed prismatic crystals, with pyramidal end terminations; also in rounded grains. With the exception of rutile, none of the other minerals exhibit idiomorphic outlines.

Mechanical Composition. — The mechanical analysis of this and the other samples of sand examined was carried out with a set of standard laboratory screens supplied by the Mining and Metallurgical Institute.

In these screens the apertures, unfortunately, are in English units—5, 12, 20, etc., meshes to the inch—and a comparison with the metric scale adopted by Boswell cannot, therefore, be made, except in the case of the 12, 50, and 120 screens, which, as the following table shows, have apertures of approximately 1, .25, and .1 millimetres. There is no screen in the set with an apperture corresponding even approximately with .5 mm.

TABLE GIVING APERTURES OF 1MM. STANDARD SCREENS USED.

Mesh or Apertures per Lin. In.	Diameter of Wire.		Aperture.	
	In.	Mm.	In.	Mm.
5	0·1	2·540	0·1	2·540
12	0·0417	1·059	0·0416	1·056
16	0·0313	0·795	0·0312	0·792
20	0·025	0·635	0·025	0·635
30	0·0167	0·424	0·016	0·421
50	0·01	0·254	0·01	0·254
60	0·0083	0·211	0·0083	0·211
80	0·0063	0·160	0·0062	0·157
120	0·0041	0·0104	0·0042	0·107
200	0·0025	0·063	0·0025	0·063

The mechanical composition of the Pienaarspoort sand was found to be as follows:—

		+ 5 mesh, i.e.					+ 2·54	mm. aperature	=	0·01	per cent.
− 5	and	+ 12	,,	,,	− 2·54	and	+ 1·056	,, ,,	=	0·02	,,
− 12	,,	+ 20	,,	,,	− 1·056	,,	+ ·635	,, ,,	=	1·60	,,
− 20	,,	+ 30	,,	,,	− ·635	,,	+ ·424	,, ,,	=	8·37	,,
− 30	,,	+ 50	,,	,,	− ·424	,,	+ ·254	,, ,,	=	41·71	,,
− 50	,,	+ 60	,,	,,	− ·254	,,	+ ·211	,, ,,	=	10·29	,,
− 60	,,	+ 80	,,	,,	− ·211	,,	+ ·157	,, ,,	=	9·00	,,
− 80	,,	+120	,,	,,	− ·157	,,	+ ·107	,, ,,	=	16·91	,,
		−120	,,	,,			− ·107	,, ,,	=	12·00	,,

Sand grade (i.e. particles falling within the limits 1·056 mm. and ·107 mm.) = 87·97 per cent.

The results of the analysis show that the sand is rather poorly graded, being much inferior in this respect to most European and American glass sands, and also inferior to the Zandfontein sand, to be presently referred to. The most striking feature in comparison with the Zandfontein sand is the large proportion of superfine sand which it contains.

The Pienaarspoort sand could be greatly improved by coarse screening through a 20-mesh screen to remove particles $<$ .635 mm. diameter, followed by fine-screening through a 60-mesh screen to remove particles $<$ .211 mm. diameter. The screened and washed product would be well suited, by virtue of its chemical and mineralogical composition, to the manufacture of the better grades of white glassware.

The suitability of the sand in its natural condition for bottle-making has been amply demonstrated.

The deposit is accessible, and conditions are favourable to cheap working.

The Sand Deposits of the Moat Valley.—There are very extensive deposits of sand suitable for glass-making in the Moat Valley, the wide, flat-bottomed depression between the Magaliesberg and Daspoort ranges, north of Pretoria. They extend along the south side of the valley from the neighbourhood of Silverton as far west, at least, as the western boundary of the farm Zandfontein No. 93, and probably mark the position of outliers of Karroo sandstone. The most important deposits are on the farm Zandfontein, which is traversed from east to west by a sand belt some hundreds of yards in width, and at least two miles long. The sand is dug in shallow pits, and is used for building purposes, and by the Pretoria Mines, Ltd., for making the "pig-beds" in which their iron is cast. There are several groups of sand pits. The most easterly of these is situated two and a half miles to the west of Daspoort Cement Factory, and about 500 yards north of Daspoort range. Sections exposed in this and adjacent pits show a variable thickness of overburden in the form of dark-grey sandy loam, which merges downward into greyish-white sand, mottled and streaked with iron oxide, or into yellow sand, overlying a persistent layer of pale greyish-white sand. The following sections may be taken as fairly representative:—

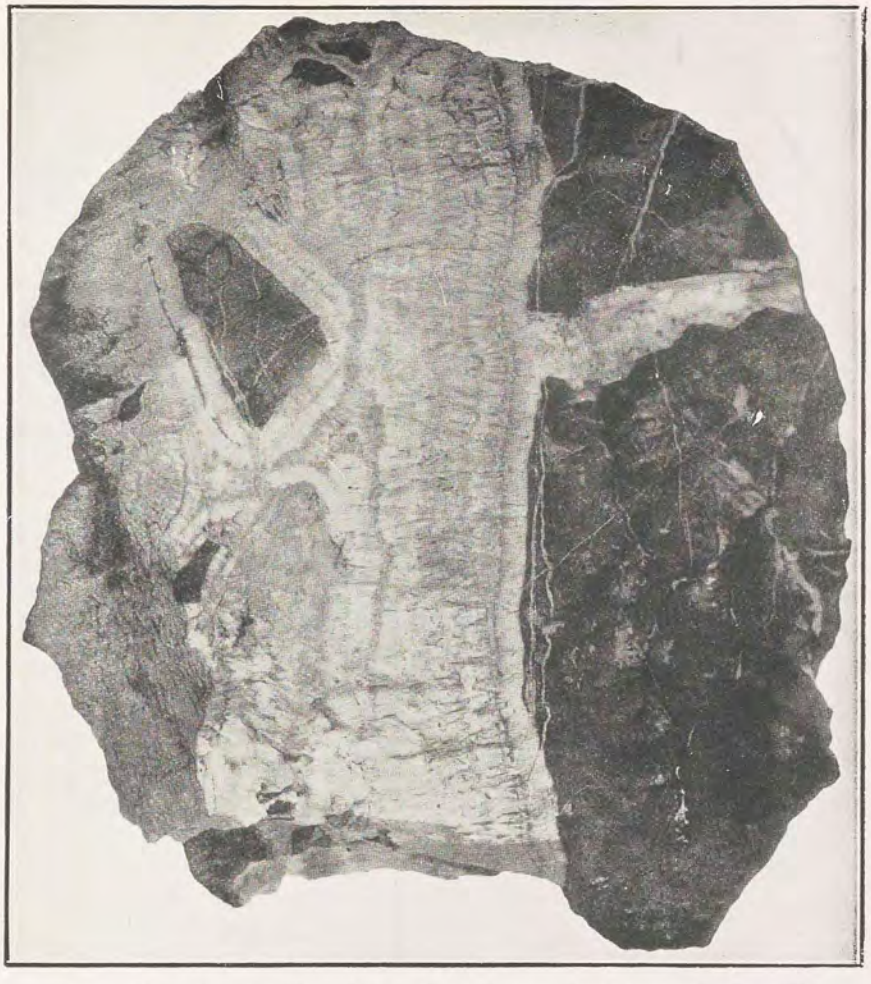
	(1.)	(2.)	(3.)
Dark-grey sandy loam	3ft. 0 in.	2 ft. 6 in.	3 ft. 0 in.
Greyish-white sand mottled and streaked with iron oxide	1 ft. 0 in.	—	1 ft. 0 in.
Yellow sand.....	—	3 ft. 6 in.	—
Pale greyish-white sand	2 ft. 6 in.	2 ft. 6 in.	4 ft. 0 in.

(1) Section exposed in most easterly pit.
(2) Section exposed in pit about 300 yards to the west.
(3) Section exposed in most westerly of eastern group of pits.

The upper limit of the white sand was found in several instances to coincide approximately with the surface of the underground water-table. Its light colour and purity may thus be due to the leaching effect of the underground water percolating slowly towards the centre of the Moat Valley.

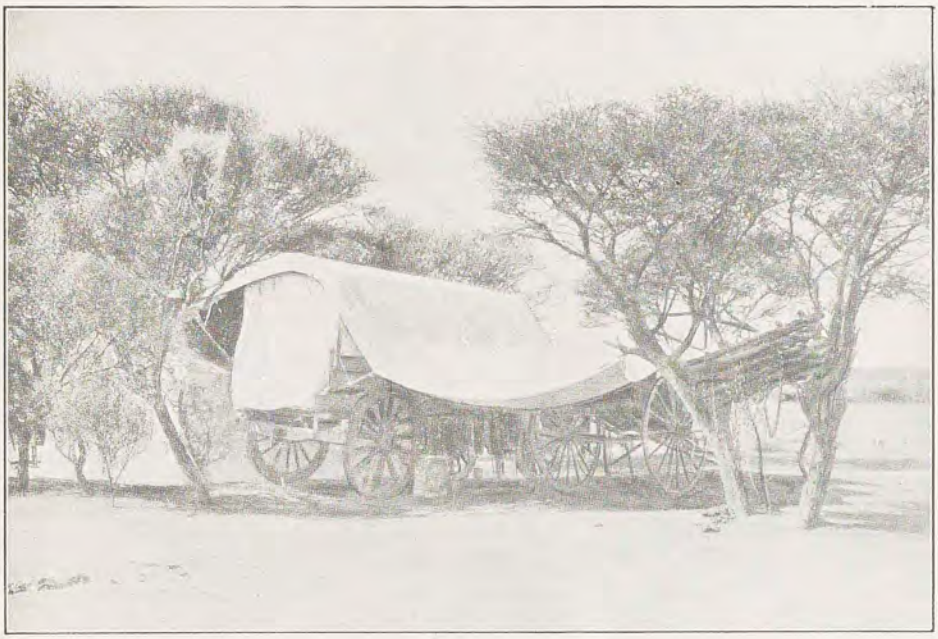
In the deepest of the pits, the white sand is seen to merge downward into a friable even-grained white sandstone, and similar sandstone is said to have been struck in some of the other pits. The sandstone, as already suggested, is probably of Karroo age. Further evidence, however, is needed to settle the point.

The white sand appears to vary somewhat in quality. The purest material is that exposed in the most westerly of the eastern group of pits (section 3), where the layer is 4 ft. in thickness.



BRECCIATED ORE OF MAIN LODE, No. 3 WINZE, WELGEVONDEN No. 1772.
Shows crustified combs composed of slender quartz crystals deposited on the wall of the lode and on fragments of felsite. The vein on the right represents a branch fissure in felsite filled with quartz of same age as that forming the outermost crust. (*Actual size.*)

CRUSHING PLATINUM ORE PRELIMINARY TO PANNING.

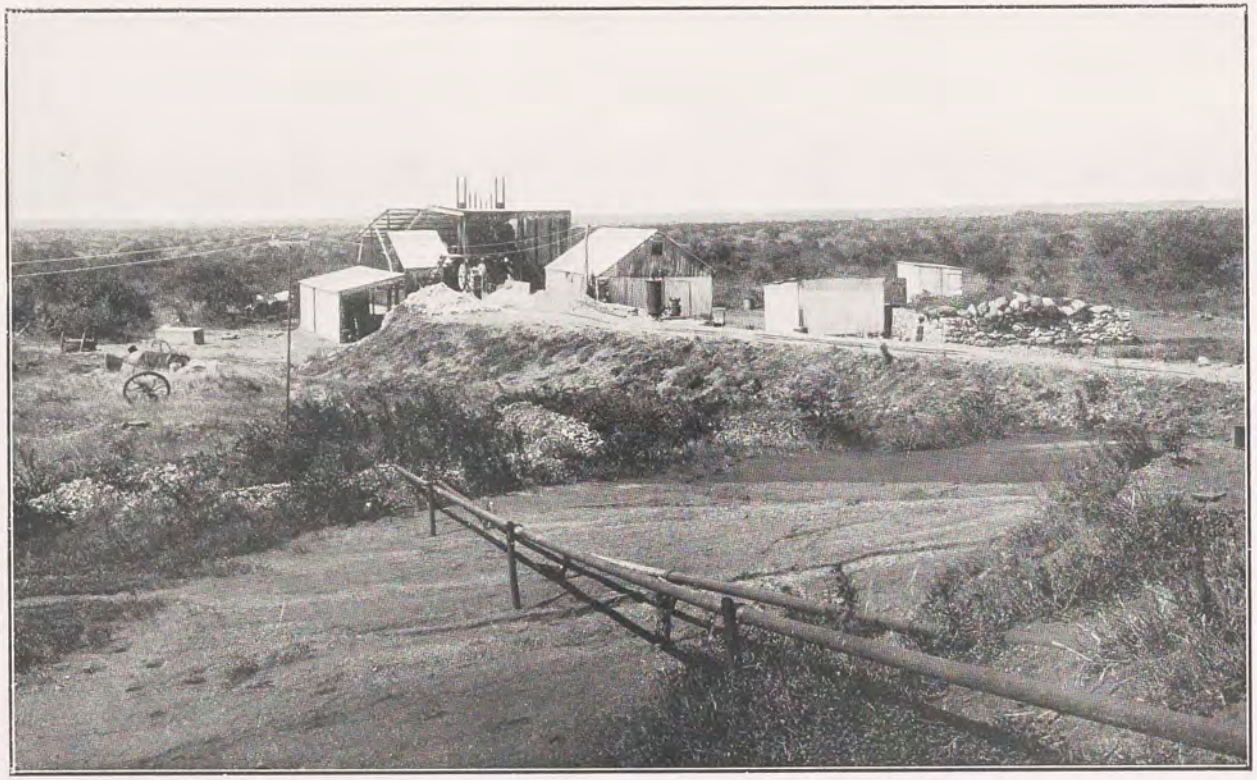


ON TREK.

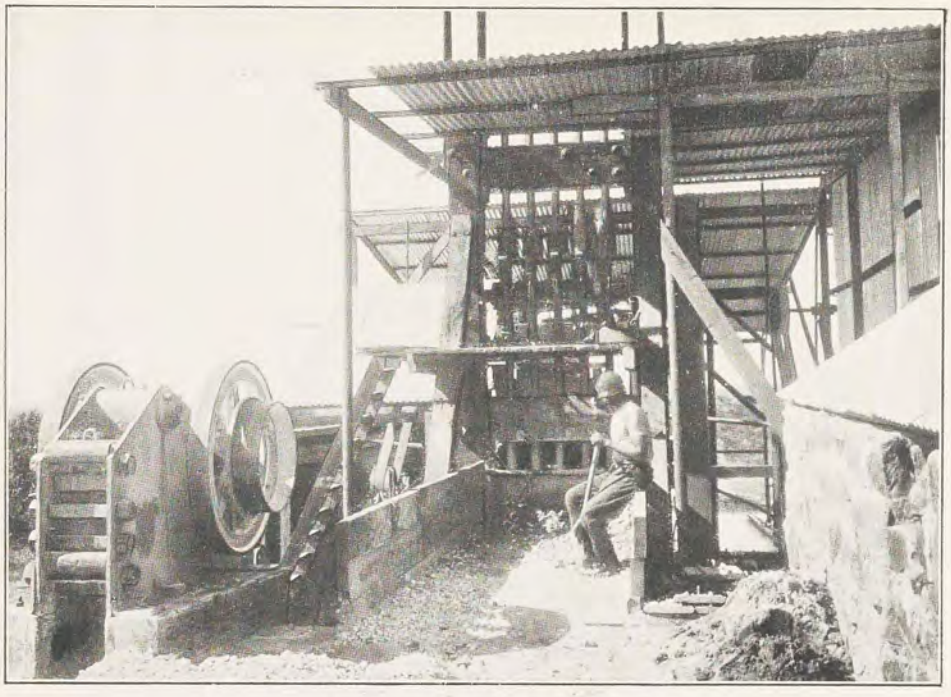
How the pioneers of civilization, the Voortrekkers of old, penetrated from the coastal fringe of the colonies into the little-known, savage-infested regions of the interior.

MODERN TRAVEL IN SOUTH AFRICA.

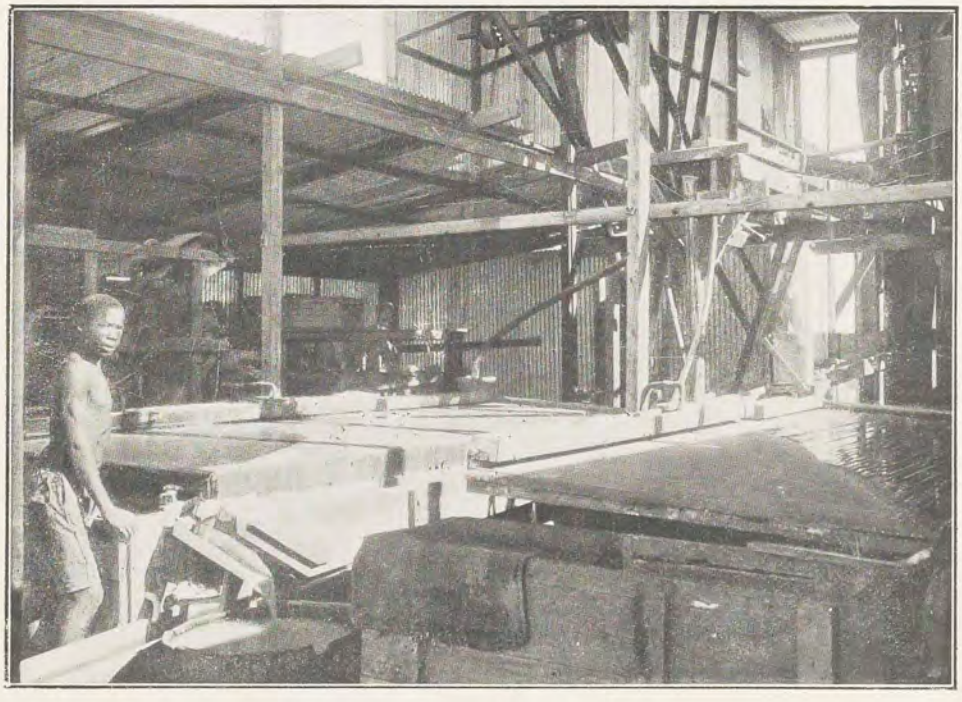
The ox-w gon and the stage-coach have given way to the train-de-luxe, which for comfort and convenience is hardly superseded on the railway systems of any other part of



THE CORUNDUM INDUSTRY, BANDOLIERKOP, TRANSVAAL.
A General View of the Mill.



CRUSHING THE ORE.



INTERIOR OF THE GRINDING MILL.
Showing the Spitzkasten, Wilfley Tables, and Magnetic Separator (on the left).

A partial chemical analysis of a representative sample of pale, greyish-white sand from this pit, carried out by Dr. B. de C. Marchand, Chemist, Department of Agriculture, showed:—

SiO_2.....	99·37 per cent.
Fe_2O_3.....	0·31 „

Mineralogical Composition. — The microscopic examination of the sand proves it to be composed almost exclusively of grains of quartz. Many of these are completely coated with films of ferruginous, clayey matter, and few are quite free from iron stains. Sub-angular grains make up the bulk of the sand, but many of the larger grains are exceedingly well rounded. It is remarkably free from heavy minerals, containing only 0.081 per cent. of particles of specific gravity > 3.3.

Magnetic particles make up 45 per cent. of the concentrate, and small, well-formed zircon crystals about 5 per cent. of the non-magnetic portion. The latter also contains small grains and crystals of rutile and irregular grains of ilmenite, leucoxene, and limonite.

A grading analysis of the sand gave the following result:—

		+ 5 mesh, i.e.					+ 2·54 mm. aperture	=	0·00 per cent.
− 5 and	+ 12	„	„	− 2·54 and	+ 1·056	„	„	=	0·04	„
− 12 „	+ 20	„	„	− 1·056 „	+ ·635	„	„	=	7·55	„
− 20 „	+ 30	„	„	− ·635 „	+ ·424	„	„	=	14·11	„
− 30 „	+ 50	„	„	− ·424 „	+ ·254	„	„	=	57·50	„
− 50 „	+ 60	„	„	− ·254 „	+ ·211	„	„	=	10·8	„
− 60 „	+120	„	„	− ·211 „	+ ·107	„	„	=	5·2	„
	−120	„	„		− ·107	„	„	=	4·50	„

Sand grade (i.e. particles falling within the limits of 1·056 mm. and 0·107 mm. diameter) = 95·1 per cent.

The result shows the sand to be much better graded than the Pienaarsport sand, 71.61 per cent. falling within the limits of 0.635 mm. and 0.254 mm., and 82.41 per cent. within the limits of 0.635 mm. and 0.211 mm. It is in this respect, however, still much inferior to the best European and American glass sands, and could be greatly improved by screening. The chemical, mineralogical, and mechanical composition of the sand prove it to be admirably adapted to the manufacture of white bottles and better-grade white glassware. With washing and screening it would, in all probability, be good enough for plate-glass.

The sand exposed in other pits, though not quite as pure, is probably equally well suited to the production of ordinary glass-ware.

The available reserves of sand on the farm Zandfontein must be enormous, and conditions are favourable to cheap exploitation. The sand was (in 1919) sold for building purposes at from 1s. 6d. to 2s. per wagon load of three tons. It could easily be delivered on rail at Hercules Station at 2s. 6d. per ton.

At Silverton, about twenty miles from Pretoria, on the Pretoria-Delagoa Bay line, sand for building purposes has for many years been dug in shallow pits. The sand occurs in exactly the same position relative to the Daspoort range as that at Zandfontein, in a layer from 2 ft. to 4 ft in thickness, beneath a thickness of from 2 ft. to 2 ft. 6 in. of dark-grey sandy loam.

It is of grey or yellow colour, with streaks and patches of brownish-red ferruginous matter, and while not nearly so pure or well-graded as the Zandfontein sand, is quite good enough for ordinary bottle-glass.

Kilnerton.—At Kilnerton, about five miles to the east of Pretoria, and again in the same position relative to the faulted continuation of the Daspoort range as the Zandfontein sand, there is a fairly extensive deposit of pale-

greyish sand, streaked with iron oxide. The sand layer, which has a minimum exposed thickness of about 3 ft., is overlaid by 1 ft. to 2 ft. of grey sandy loam. It is used for building purposes.

Wonderboom Poort.—There are extensive deposits of greyish-white sand to the north and north-west of Wonderboom Poort, near Pretoria, that appear to be well suited for glass-making. A sample of washed sand from this locality was analysed in the laboratory of the Geological Survey, with the following result:—

SiO_2	99·5 per cent.
Fe_2O_3	0·09 „
Loss on ignition	0·05 „

Olifantsfontein.—There is a fairly extensive deposit of sand, suitable for bottle glass, on the farm Olifantsfontein, near Olifantsfontein Station, on the Pretoria-Johannesburg railway. A company, called the Elephant Glass Works Co., Ltd., was formed some years ago to erect a glass factory at this locality, but the project did not materialize.

Vereeniging.—There are great accumulations of fairly pure sand on the Orange Free State side of the Vaal River at Vereeniging. The best material, forming a layer 1 ft. 6 in. in thickness, analyses:—

SiO_2	98·10 per cent.
Fe_2O_3	0·30 „

Sand of somewhat inferior quality, occurring in a layer with a maximum exposed thickness of 4 ft., analysed:—

SiO_2	95·5 per cent.
Fe_2O_3	1·55 „

Viljoens Drift.—There are similar deposits of sand lower down the Vaal River at Viljoens Drift and other localities.

Bronkhorstspruit.—Sand suitable for bottle-making occurs in considerable quantity in the neighbourhood of Bronkhorstspruit, on the Pretoria-Delagoa Bay railway. It is rather variable in quality, as is clearly indicated by the following analyses of samples taken from four different localities:—

	1.	2.	3.	4.
SiO_2	94·4	96·2	93·0	92·8
Fe_2O_3	1·6	0·8	0·8	1·3

Analyst: A. F. Crosse.

Tweefontein.—At the Tweefontein Colliery, near Witbank, a belt of sand 80 yards wide has been proved over a distance of about a mile. Sections exposed in a sand pit adjoining the colliery show:—

Sandy soil with grass roots	1 ft. to 1 ft. 3 in.
Yellow sand mixed with oxide of iron	2 ft.
Fine white sand	1 ft. 2 in.
Clayey sand with oxide of iron	2 ft. 7 in.

The white sand was examined with a view to determining its suitability for glass-making. It is of almost pure white colour, being superior in this respect to any other South African sand that has come under observation. On strong ignition it reddens slightly. Under the microscope the sand, which is very fine-grained, is seen to be composed for the most part of subangular grains of quartz, though many of the finer particles are quite angular. Most of the grains have a thin coating of ferruginous clayey matter.

Heavy mineral of specific gravity > 3.3 make up 0.016 per cent. of the whole. Among them minute crystals of zircon and grains of magnetite are fairly common.

A partial chemical analysis of the sand by Dr. J. McCrae showed:—

SiO_2	99·26 per cent.
Fe_2O_3	0·23 „
Al_2O_3	0·28 „
CaO and MgO	traces
Loss on ignition	0·23 „

It is thus of great purity. With washing, it would probably yield a product containing well below 0.1 per cent of iron oxide.

The mechanical analysis of the sand gave the following result:—

		+ 5 mesh, i.e.					+ 2·54 mm. aperture	= 1·00 per cent.
− 5 and	+ 12	,,	,,	− 2·54	and	+ 1·056	,,	= ·50	,,
− 12 ,,	+ 16	,,	,,	− 1·056	,,	+ ·795	,,	= 1·70	,,
− 16 ,,	+ 20	,,	,,	− ·795	,,	+ ·635	,,	= 2·30	,,
− 20 ,,	+ 30	,,	,,	− ·635	,,	+ ·424	,,	= 9·00	,,
− 30 ,,	+ 50	,,	,,	− ·424	,,	+ ·254	,,	= 23·50	,,
− 50 ,,	+ 80	,,	,,	− ·254	,,	+ ·157	,,	= 29·50	,,
− 80 ,,	+120	,,	,,	− ·157	,,	+ ·107	,,	= 13·00	,,
−120 ,,	+200	,,	,,	− ·107	,,	+ ·063	,,	= 7·00	,,
	−200	,,	,,			− ·063	,,	= 12·00	,,

Sand grade (i.e. particles falling within the limits 1·056 mm. and 0·107 mm.) = 79·50 per cent.

The results prove the sand to be much finer grained than even the Pienaarspoort sand. The comparatively high proportion of superfine material would militate against its use in an unscreened condition. If it were coarse-screened through a 30-mesh screen to remove particles <0.424 mm. diameter, and fine-screened through an 80-mesh screen to remove particles <0.157 mm. diameter, the resulting product would be eminently suited to the manufacture of the better grades of white glassware. It would take approximately two tons of unscreened sand to produce one ton of screened; but as conditions are favourable to cheap working, the screened product could probably be delivered on rail at 6d. per ton.

Natal Occurrences: Sandspruit, near Malonjeni Station, Dundee District.—The Union Glass, Ltd., employ in their new bottle factory near Dundee, river sand occurring in the form of low terraces and banks in the bed of the Sandspruit—a tributary of the Buffalo River—about three-quarters of a mile south-east of Malonjeni Station, on the Vryheid line. The company has secured rights over a stretch of about two miles of the river bed, which is from 100 ft. to 200 ft. in width. The available reserve of sand within this stretch is practically inexhaustible, as it is replenished each rainy season.

The sand is of brownish-yellow colour. It contains pebbles of sandstone, shale, and dolerite, and small consecrations of calcareous and ferruginous matter. Another feature is the presence of numerous small fragments of coal derived from the colliery dumps within the base of the stream.

A partial chemical analysis of a representative sample of the sand, from which all coarse matter had been removed by putting it through a sieve with round holes of 2 mm. diameter, gave the following results.—

SiO_2.....	93·61 per cent.
Fe_2O_3.....	1·42 ,,
Al_2O_3.....	2·20 ,,

Mineralogical Composition.—Under the miscrope the sand is seen to be made up mainly of subangular grains of quartz, most of which are coated or stained with iron oxide.

As might be expected of a river sand, it is comparatively rich in heavy minerals, among which grains of pink garnet predominate.

Actually the heavy crop, composed of particles of specific gravity > 3.3 amounts to 0.23 per cent. Magnetic particles make up 17 per cent. of the concentrate, and grains of garnet about 25 per cent. Other minerals identified include zircon, blood-red rutile, cyanite, saurolite, and ilmenite.

The mechanical analysis of the sand was as follows:—

		+ 5 mesh, i.e.					+ 2·54 mm. aperture	= ·1 per cent.
− 5 and	+ 12	,,	,,	− 2·54	and	+ 1·056	,,	= 2·0	,,
− 12 ,,	+ 16	,,	,,	− 1·056	,,	+ ·792	,,	= 1·0	,,
− 16 ,,	+ 20	,,	,,	− ·792	,,	+ ·635	,,	= 21·1	,,
− 20 ,,	+ 50	,,	,,	− ·635	,,	+ ·254	,,	= 69·4	,,
− 50 ,,	+120	,,	,,	− ·254	,,	+ ·107	,,	= 5·0	,,
	−120	,,	,,			− ·107	,,	= ·8	,,

Sand grade (i.e. grains between the limits 1·056 mm. and 0·107 mm. diameter) = 97·1 per cen

The analysis proved that, while the sand is much coarser than that from the neighbourhood of Pretorie, it is, from the point of view of the glass maker, better graded than either the Pienaarspoort or the Zandfontein sand.

If it were put through a standard 20-mesh screen, and the portion remaining on the screen rejected, there would be obtained a product composed to the extent of 99.2 per cent. of particles ranging from 0.635 mm. to 0.107 mm. diameter, and eminently adapted, both as regards chemical and mineralogical composition, to the manufacture of dark bottle-glass.

Burning to remove particles of coal and organic matter would still further improve it.

Talana Hill, near Dundee.—The Union Glass, Ltd., originally employed coarse yellow sand found on the slopes of Talana Hill, which adjoins the factory site. The sand was derived from a thick bed of stadstone cropping out on the side of the hill. A partial chemical analysis of the sandstone showed:—

SiO_2	95·5 per cent.
Fe_2O_3	1·2 „

The sand itself analyses:—

SiO_2	95·4 per cent.
Fe_2O_3	1·2 „

The sand contains a good deal of fine coal and small concretions of iron oxide. To eliminate the coal it was burned in a small gas-fired furnace.

Under the microscope it is found to be composed principally of subangular and angular grains of quartz, almost without exception coated with films of ferruginous matter

It contains 0.18 per cent. of particles of specific gravity > 3.3. Magnetic particles made up 19 per cent. of the concentrate. The non-magnetic portion is fairly rich in crystals and grains of rutile. Other minerals present include zircon, garnet, ilmenite, and cyanite.

The mechanical analysis of the sand was as follows:—

		+ 5 mesh, i.e.				+ 2·54	mm. aperture	= 2·1 per cent.
− 5 and	+ 12	„	„	− 2·54 and		+ 1·056	„ „	= 8·0 „
− 12 „	+ 16	„	„	− 1·056 „		+ ·792	„ „	= 9·0 „
− 16 „	+ 20	„	„	− ·792 „		+ ·635	„ „	= 11·0 „
− 20 „	+ 50	„	„	− ·635 „		+ ·254	„ „	= 46·0 „
− 50 „	+120	„	„	− ·254 „		+ ·107	„ „	= 20·0 „
	−120	„	„			− ·107	„ „	= 3·5 „

Sand grade (i.e. particles falling within the limits 1·056 mm. and 0·107 mm. diameter) = 86·4 per cent.

The results prove that the sand is coarser than the Malonjeni sand, and not nearly so well graded. Like the Malonjeni sand, it could be greatly improved, as regards grade, by putting it through a screen with 20 holes to the linear inch.

Cape Province.—Quartz sand, well adapted to the manufacture of glass, occurs in the south-western districts of the Cape Province, in the beds of many of the rivers rising in the long southern and south-western mountain ranges; also on the Cape Flats near Capetown.

Philippi, Cape Flats.—The best deposit of glass sand so far discovered on the Cape Flats is at the locality named. It is of exceptional purity, containing only 0.032 per cent. of ferric oxide, and is thus especially adapted to the manufacture of white glass. It is used on a big scale by the Union Glass, Ltd., of Dundee, for their white bottles. The sand is rather coarse and has to be screened before use, but otherwise proved very satisfactory. It compares favourably with the best white Belgian sand.

Siliceous Rocks.—Apart from sands, there are in the Union large deposits of siliceous rocks, suitable for glass-making. These include sandstone, quartzite and veinquartz. Messrs. R. Wood & Sons, of Durban, for their better class bottles, employed

as a source of silica an even-grained, friable, greyish-white sandstone, containing a good deal of kaolinized felspar, which occurs in the Port Shepstone district, on the south coast of Natal. The rock appears to be well adapted to the purpose.

Mine Sand.—The sand of the mine dumps on the Witwatersrand is in many quarters regarded as a valuable source of silica for glass-making. As a matter of fact, it is unsuited to this purpose, as it contains from 4 to 6 per cent. of pyrite. The latter could, of course, be eliminated by concentration, but this would make the sand far more expensive than the natural sand available at so many localities.

Fluxes.—The Union Glassworks at Dundee use "converted" sodium sulphate, prepared from "nitre-cake," a by-product of nitric acid manufacture, which can be supplied in large quantity and at a moderate price by the various explosive works in the Union. The converted sulphate contains from 91 to 95 per cent. of Na_2SO_4, and about 0.2 per cent. of ferric oxide. To assist in the fluxing of the batch, a proportion of the sodium carbonate obtained from the South African Alkali, Ltd., is employed together with the "converted" sulphate.

Other Localities in Natal.—Pure white sand is said to be available at Sweetwaters, near Maritzburg, and at Gezubuso. Sand suitable for bottle glass occurs at Jacobs, just outside Durban.

Lime.—Pure limestone suitable for glass making is available at Potgietersrust and other localities in the Transvaal, also at Taungs in Bechuanaland.

Fluorspar.—Pure fluorspar for fluxing purposes is mined in large quantities in the Zeerust district of the Transvaal.

Manganese Dioxide.—Manganese dioxide, sufficiently free from iron to be used as a decolourant in glass-making, is obtainable at Derdepoort, near Hatherley, and from the neighbourhood of Krugersdorp.

Refractory Materials.—The refractory materials employed in the construction of glass furnaces, which include fire-clay blocks, fire-bricks, fire-clay, and silica bricks, are all obtainable locally.

Fire-clay Blocks.—These are made by several firms in the Transvaal. Our fire-clays—notably those occurring in the neighbourhood of Boksburg—are of excellent quality.

Silica Bricks.—Silica bricks of good quality are made at Vereeniging. The analysis of a Vereeniging silica brick gave the following result:—

SiO_2	94·4	per cent.
Al_2O_3	3·2	,,
CaO	1·5	,,
MgO	0·2	,,
Fe_2O_3	0·6	,,
	99·9	,,

Existing and Defunct Establishments.—A number of attempts have been made to manufacture bottles on a commercial scale in the Union; thus at Hatherley, near Pretoria; Dundee; Durban; Denver, near Johannesburg; and Glencairn, near Simonstown.

The Hatherley Glass Factory was built in 1896, primarily to supply bottles for the Hatherley Distillery. It was in successful operation until 1902, when it was closed down, owing partly to the cutting off of supplies of coal and raw materials, and partly to the shutting down of the Hatherley Distillery.

Since 1924 the Union Glass, Ltd., have been making dark and white bottles on a big scale at their works at Talana, near Dundee, Natal. The difficulties inherent in starting an industry of this nature are being rapidly overcome, and given sympathetic treatment, the ultimate success of the project seems assured.

IMPORT DATA.

Earthenware and Chinaware.

	Chief Sources.	1925.		1916.	
		Quantity.	Value.	Quantity.	Value.
			£		£
Crucibles	United Kingdom	—	19,230	—	—
Building bricks	United Kingdom.....No.	26,359	488	23,120	49
Firebricks	United Kingdom, and United States of America No.	262,471	5,188	—	2,890
China and Porcelainware	United Kingdom and Germany	—	39,539	—	—
Earthenware and Stoneware	United Kingdom and France	—	218,122	—	—
Insulators, Porcelain	United Kingdom and Germany	—	20,951	—	—
Pipes and Piping	United Kingdom	—	2,210	—	5,479
Sanitaryware	United Kingdom	—	39,972	—	—
Tiles: Flooring, paving, and wall	United Kingdom, Belgium, Germany & Holland No.	2,677,464	26,399	—	8,690
Tiles: Roofing	United Kingdom, France, and Portugal.....No.	504,675	3,647		
Unclassified China and Porcelainware	United Kingdom, France, and Japan	—	—	—	19,150
Unclassified earthen and stoneware	United Kingdom and Germany	—	—	—	159,189
	TOTAL	—	£373,746	—	£195,447

Glass.

	Chief Sources.	Value.	
		1925.	1916.
		£	£
Empty bottles and jars	United Kingdom, Germany, United States and Japan	170,956	183,778
Plate-glass	United Kingdom and Belgium	83,910	37,494
Window glass	United Kingdom and Belgium	41,488	42,342
Unclassified	United Kingdom, Germany, Belgium, Holland	137,809	75,681
	TOTAL.....£	434,163	339,295

Cement.

	Chief Sources.	1925.	
		lb.	Value.
			£
Building	United Kingdom, Germany, Sweden, and Holland	93,519,620	101,090
Liquid	Canada	8,867	255
Roofing	United Kingdom and United States	258,976	2,502
Unclassified	United Kingdom and United States	229,415	2,329
	TOTAL	—	£106,176

The following statistics of production show that at the same time considerable expansion has taken place in the local industry, and the fact that imports have been maintained indicates a rising demand. This is a very healthy sign that this industry is a sound investment.

BRICK, TILE, EARTHENWARE, AND POTTERY WORKS.

1918–19 to 1924–25.

Quantity and Value of Articles Manufactured or Produced.

Date.	Bricks.					
	Building.		Fire.		Other.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	No.	£	No.	£	No.	£
1918–19	147,017,458	368,599	3,322,899	25,634	851,129	14,553
1919–20	191,059,374	529,287	3,852,965	24,176	1,375,361	15,899
1920–21	212,332,021	618,954	2,880,710	23,258	1,190,895	12,591
1921–22	194,718,260	544,501	2,349,282	20,562	1,398,494	17,098
1922–23	237,865,534	603,014	2,106,201	16,653	851,303	9,922
1923–24	242,986,298	658,150	3,249,249	20,848	1,048,795	13,893
1924–25	252,693,338	769,693	3,572,666	26,941	2,043,063	27,456

Date.	Tiles.				Fire-clay and Fire-clay Ware.
	Roofing.		Other.		Value.
	Quantity.	Value.	Quantity.	Value.	
	No.	£	No.	£	£
1918–19	4,597,664	54,733	295,731	4,000	14,308
1919–20	4,110,703	66,102	620,991	6,878	13,308
1920–21	5,344,595	88,372	347,035	3,836	17,996
1921–22	4,896,085	77,738	691,680	11,270	16,490
1922–23	4,999,513	76,045	898,074	13,376	16,404
1923–24	6,014,202	90,323	1,650,815	19,695	17,104
1924–25	5,412,069	74,888	1,185,780	19,715	11,689

Date.	*Earthenware and Pottery.	Other Articles Manufactured.	Total Value of Articles Manufactured.
	Value.	Value.	Value.
	£	£	£
1918–19	51,614	13,308	546,749
1919–20	49,662	36,531	741,843
1920–21	74,090	43,234	882,331
1921–22	85,026	25,703	798,388
1922–23	82,579	17,033	835,026
1923–24	79,556	16,887	916,456
1924–25	107,345	16,661	1,054,388

* Includes sanitary pipes and fittings.

PRODUCTION IN THE PRINCIPAL INDUSTRIAL CENTRES.

Date.	Building Bricks.			
	(1) Cape Peninsula.	(2) Port Elizabeth.	(3) Durban.	(4) Witwatersrand.
	No.	No.	No.	No.
1919–20	20,159,650	*	3,197,000	85,362,980
1920–21	26,436,740	*	3,565,000	95,837,406
1921–22	28,473,813	*	4,153,000	84,955,765
1922–23	38,157,025	5,973,089	4,565,400	101,368,715
1923–24	42,055,920	8,584,934	5,268,575	91,408,826
1924–25	42,147,500	8,999,000	7,640,849	101,781,739

* Less than four establishments, and therefore not separately enumerated.

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CHAPTER XVII.

THE MANUFACTURE OF CONFECTIONERY, CANNED AND DRIED FRUITS AND VEGETABLES.

AMONGST the basic industries of a country is the production of food materials. In the olden days food was distributed for the most parts in the form in which it was grown, and submitted to some sort of preparation or cooking prior to consumption. Under the complex conditions of modern life, however, there has intervened another step. This is the conversion of elementary food products, by canning or other means, into a form which facilitates distribution by enabling foods to be kept without deterioration over long periods.

In South Africa fruits and vegetables are grown on a very large scale. South African fruit is well known in the world's markets. At the same time large quantities of canned and preserved goods are imported. This anomalous position presents a field for development.

The dairying industry in South Africa has assumed a position of importance. This may be seen by examining statistics of production—imports and exports. Large numbers of farmers are now specializing in dairy farming and are improving their cattle with a view solely to increasing the output of milk and cream. To-day the Union supplies itself and also exports. A few years ago the Union was a large importer. There are registered creameries and dairies in all parts of the Union.

In view of this position the manufacture of condensed milk and milk powder should develop in South Africa. The products, however, would have to find an export market since the supply of fresh milk and cream is adequate to take care of all South African requirements, and distribution to all parts is made possible by the use of railway refrigeration cars.

Confectionery.

Jams and Jellies, Custard Powders, Chocolates and Sweets, Ice-Cream.

The successful manufacture of these products is largely a case of the application of the principles of colloid chemistry. For instance, in gum drops and candies, gum arabic, gelatine, albumen, and other colloids are incorporated to prevent crystallization of the sugar. These colloids not only perform this function; they add also to the food value and act in some measure as preservatives, keeping the food in saleable condition, the preservative action being rather physical than chemical. In ice-cream manufacture, the addition of colloids, such as eggs, gelatine, or other ingredients, in small quantities make the cream mellow and velvety, and, generally speaking, preserves its texture. In this case colloids also inhibit the coagulation of casein, an irreversible hydrosol, and so act as "protective colloids" and render the ice-cream more digestible.

Expansion in the confectionery industry in the Union is being hampered owing to the scarcity of such raw materials as gelatine, glucose, and colouring matter.

Gelatine.—This is a very valuable food. It facilitates digestion and conserves the body's nitrogen supply. A few concerns in South Africa are manufacturing glue at present. These

concerns might be able to supply high-testing sweet glues for food materials, but this is doubtful. The raw materials for glue or gelatine manufacture, such as bones and hides, both animal and fish, are, however, plentiful in South Africa, and any large concern manufacturing its confectionery would no doubt find it possible to make its own gelatine.

Casein.—Plentiful supplies of milk are obtainable in any part of South Africa. The same applies to all dairy products.

Eggs.—Fresh or preserved eggs can be obtained in any part.

Glucose.—The position in regard to glucose is treated fully in the note on the more efficient utilization of maize. Dextrine is also treated in the same article.

Gum Arabic.—At present all supplies of gum arabic are imported. The imports in 1926 were 15,224 lb., worth £342.

Sugar is, of course, obtainable in South Africa, a crop running into about 200,000 tons of sugar per annum being raised on the Natal coast.

Colouring Matters.—These are unobtainable in South Africa and would have to be imported from overseas.

Refrigerating Equipment. — No machinery in this line is made in South Africa, and its importation from Britain, Canada, or the United States would be necessary; in fact, practically no equipment is obtainable in South Africa, though a few smaller pieces could be made to order.

Various Products.

Chocolates and Cocoa Products.—South Africa is very close to the world's cocoa (correctly *cacao*) growing centre. Considerable expansion has taken place in this branch of agriculture of late years, especially in the Belgian Congo. The cost of sea transportation of raw beans down the coast to Capetown or other Union port is not great. It would thus seem that South Africa should be quite a large producer of cocoa, chocolate, and related products, such as flavourings for ice-cream and cold drinks. Domestic consumption of these products runs into nearly £50,000 annually. South Africa should become the distributing centre of cocoa products for the Southern Hemisphere.

Baking-powder.—The usual constituents of this are sodium bicarbonate, cream of tartar, and starch.

Cream of Tartar.—In 1926, 264,424 lb. of tartaric acid and 131,566 lb. of cream of tartar, valued respectively at £15,547 and £5,708, were imported and 132,294 lb. of argol, valued at £1,414, were exported to the United Kingdom and Holland. There is no reason why argol should not be utilized for the manufacture of tartaric acid and cream of tartar in South Africa, and, further, the supplies of argol could be obtained in greatly increased quantities from the wine-growing districts of the Cape.

Sodium bicarbonate is at present entirely an imported product, but for its manufacture, South African soda ash could be used.

The Soda-Fountain Business.

In a country where very hot summers are experienced in all parts, and where very cold winters are rare, there should be a large and promising field for iced drinks, sodas, and the hundred-and-one articles usually dispensed from that most typical of American institutions, the drug store.

It is well, however, first to lay stress on the fact that these products must be introduced. Considerable advertising is necessary, but if this be done on a large enough scale, and according to the principles of true advertising, which are startling in attractiveness and of unending variety, success may be assured.

Most of the ingredients of cold drinks have already been mentioned—sugar, fruit juices, colouring matters, etc. The only one not dealt with is the gaseous constituent, carbon dioxide. In regard to this, it need only be said there are plentiful supplies of cheap magnesite and fuel in South Africa.

Canned Goods.

South Africa is a large exporter of fruits, both fresh and dried; canned goods are not widely eaten by the people of South Africa, who prefer fresh fruit and vegetables, which are quite easily obtainable. It is a fact, however, that the distribution of these foods is inefficiently carried on in South Africa. Wastage is the greatest source of loss. In many districts fruit is never gathered since its transportation to the markets is unremunerative. The same applies to vegetables. Yet fruit and vegetables are never lacking in South African households. The reason is obvious—over-production, coupled with inefficient distribution. In the form of canned goods, however, this surplus production could be conveyed to outside markets in Europe and the East. There is, for instance, a large export trade in canned goods from America to the East, and there is no reason why a wideawake concern working on modern production lines in South Africa should not compete successfully and carry off some of this trade.

Canneries for fruit have been established on or near the coast, partly on account of the better supply of suitable labour and also on account of the proximity to the fruit districts. This is an advantage as far as the export of South African canned goods is concerned. The article produced is uniformly good and has improved considerably during the last few years. The chief centres of the industry are Durban, Port Elizabeth, and Capetown, with the Paarl and Worcester Districts of the Cape Province.

Dried and Dehydrated Fruits.—What has been said in regard to canned fruits applies equally to the question of dried fruits. The export of dried fruits has risen from just under 20,000 lb. in 1910 to nearly 8,000,000 lb. in 1926, which indicates the importance this industry is assuming, and new orchards and citrus groves are being constantly planted.

Packing Materials.

These can be divided into three classes: metallic, wooden, and paper or cardboard. Tinware is all imported or made in South Africa from imported tinplate. Boxes are made for the most part from timber imported from Scandinavia. Cardboard boxes, paper bags, wrappers, etc., are made in South Africa from imported materials. It would probably be possible for manufacturers of any of the food products discussed to import their own semi-manufactured packing materials and turn them into the forms required for use in their own plant.

It is apparent that great possibilities exist in many lines of food products produced from South African materials. Statistics show that the advantage of utilizing South African materials in the manufacture of articles formerly only obtainable overseas has been recognized. A good beginning has been made, and the necessity of importing is being reduced to a considerable extent, and in some cases (dairy produce, for instance) articles of South African manufacture are finding increasing markets overseas.

Imports and Exports of Food and Drink.

The total imports of food and drink imported into South Africa in 1926 were valued at £7,293,781; of this quantity the following detailed items are of importance in this consideration:—

Articles.	Imports.		Exports (S.A. Produce).		Chief Countries.	Imports Re-exported.
	Quantity.	Value.	Quantity.	Value.		Value.
	lb.	£	lb.	£		£
Tinned and preserved vegetables	1,025,333	28,311	—	—	—	139
Pickles	414,977	20,926	321	18	Africa	213
Sauces	834,772	49,754	5,952	226	Africa, U.K.	67
Soups	42,755	1,356	—	—	—	—
Condensed milk	10,063,917	303,965	353	10	Africa, U.K.	4,537
Gelatine	458,971	28,187	—	—	—	47
Fruit juices and cordials	—	6,292	—	3,578	Africa, U.K.	52
Dried fruit	4,195,160	59,892	(See details below.)			
Bottled and tinned fruit	401,239	14,970	3,553,951	83,137	Africa U.K., N. Zealand, Holland, U.S.A.	24
Fruit pulp	228,059	3,991	1,902	26	Africa, U.K.	—
Food extracts and essences	—	31,450	—	38	Africa	434
Flavouring (non-spirituous)	—	8,886	—	—	—	216
Flavouring (spirituous)	galls. 11,493	25,892	—	—	—	—
Jams and jellies	lb. 340,684	13,165	310,288	7,309	Africa, U.K., Aust., Germany	36
Jelly and custard powders	514,245	25,824	4,937	267	Africa, U.K.	85
Jelly crystals	52,862	2,662	—	—	—	—
All other chief manufactured sweets	2,694,371	213,170	23,146	1,741	Africa, U.K.	398
Cocoa and chocolates (unsweetened)	647.532	43,683	—	—	—	23
Cakes and biscuits	246,410	13,695	56,883*	2,932	Africa	22
Baking powder	828,736	90,771	318	33	Africa	108

* Including bread.

The following facts and figures will give some idea of the present state of the industries dealing with these products.

Dried Fruits are produced for home consumption throughout a large portion of the Union. Production of dried fruits as an article of commerce is confined to the south-western portion of the Cape Province, except in the case of apples, which are produced in large quantities and of high quality in the eastern portion of the Orange Free State. In addition to raisins and currants, there is an increasing production of prunes, pears, apricots, and peaches, with several varieties of nectarines and plums. The highest quality can be attained, and in many cases is attained, but grading is not yet uniform. The demand continues to be greatly in excess of the supply.

Production (1923-24) of dried fruits on farms in the Union:—

Apples.	Apricots.	Figs.
275,100 lb.	739,700 lb.	178,400 lb.
Peaches.	**Pears.**	**Prunes.**
1,710,600 lb.	211,600 lb.	2,923,400 lb.

Production of dried fruits (excluding currants, raisins, and dates) and candied peel, 1923-24:—

Factory production.	Farm production.	Total.
1,552,324 lb.	6,038,800 lb.	7.591,124 lb.

Jams, Jellies, Preserves, etc.

Quantity of material used in jam factories, fruit preserving works, and sweet factories, 1922-23:—

	Quantity.	Value.
Fruit	25,891,290 lb.	£138,386
Sugar	21,790,052 „	284,048
Glucose	2,663,868 „	33,582
Gelatine	162,386 „	12,437
Flavouring and colouring matter		£18,151
Other ingredients		78,922
Packing materials		203,746
Total value of materials used		769,272
Value of S.A. materials used		466,865
Value of imported materials used		302,407

Jams, Jellies, 1922-23.

	Quantity.	Value.
Total production	12,535,020 lb.	£251,784

Canned Fruits.

The following table indicates the quantities of canned and bottled fruit produced, imported, and consumed in the Union (1922-23):—

	lb.	£
Total production	3,950,808	103,219
Imports less re-exports	248,745	9,656
	4,199,553	£112,875
Exports, S.A. products	1,769,825	
Consumption	2,429,728	
	4,199,553	

IMPORTS AND EXPORTS OF CONDENSED MILK.

	1926.		1910.	
	Quantity.	Value.	Quantity.	Value.
Imports—				
Full cream	11,112,000 lb.	£303,372	20,613,656 lb.	£351,970
Skimmed	9,560 „	265	—	—
Exports—				
Condensed milk (South African produce).	174 lb.	8	100 lb.	£2

Butter and Cheese Factories.

The following are statistics of the quantity and value of materials used and articles produced in the butter and cheese factories of the Union:—

MATERIALS USED, 1922-23.

Cream or butter fat	10,116,840 lb.	(£609,727)
Milk	5,540,471 galls.	(£156,799)
Salt	767,330 lb.	(£5,121)
Preservatives	46,075 lb.	(£2,958)
Other ingredients	£26,112	
Packing materials	£51,745	
Total cost of materials	£852,462	
Value of South African materials used	£788,531	
Value of imported materials used.	£63,931	

ARTICLES PRODUCED, 1922-23.

Butter	11,863,459 lb.	(£927,523)
Cheese	5,111,611 lb.	(£252,931)
Ice	2,271,350 lb.	(£3,967)
Other products	£39,105	
Total value of articles produced or manufactured.	£1,223,526	

The following statistics of production, importation, and consumption of butter and cheese will illustrate the position of the industry and the advance that has taken place since 1910-11:—

BUTTER.

	1910-11.	1922-23.
	lb.	lb.
Creamery butter produced	5,190,514	11,863,459
Farm butter produced	6,158,779	10,551,365
TOTAL	11,349,293	22,414,824
	lb.	lb.
Imports less re-exports	3,510,308	167,922
Production less exports	11,101,563	21,864,176
CONSUMPTION	14,611,871	22,032,098

CHEESE.

	1910–11.	1922–23.
	lb.	lb.
Factory cheese produced.	225,309	5,111,611
Farm cheese produced...	319,981	547,591
TOTAL.....	545,290	5,659,202
Imports less re-exports...	4,660,131	237,504
Production less exports..	523,892	5,551,167
CONSUMPTION...	5,184,023	5,788,671

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CHAPTER XVIII.

INTERMEDIATE PRODUCTS.

THE Union Steel Corporation, Ltd., which has recently absorbed several smaller companies, plans to produce 50,000 tons of steel per annum by reducing ore at Newcastle, Natal, in addition to 25,000 tons of steel at Vereeniging, Transvaal. This will make a total production of 75,000 tons per annum. The final plan is to reduce ore at Pretoria also, and thus to raise the annual production to 300,000 tons of iron and steel. Assistance has been granted by the Union Government in the form of a bounty of 15s. per ton on pig-iron and 15s. per ton on steel under the Iron and Steel Industry Encouragement Act of 1922. Commencing in 1924-25, for three years the bounty will be 15s. per ton on either iron or steel, and will be extinguished over a period of six succeeding years.

With this assistance, there can be little doubt of the success of the steel industry in South Africa. Within the next ten years it should supply the whole South African demand and build up an export trade with the whole of Africa, and possibly with the East.

The position will become more and more favourable as time goes on, but it is apparent that a single corporation cannot handle the manufacture of all iron and steel products. Many such secondary industries are specialized lines in themselves, quite apart from the making of iron and steel. Further, with the large mineral resources in copper, manganese, tungsten, molybdenum, vanadium, chromium, etc., it will be possible to make every commercial iron and steel alloy.

Expansion in the industries which already exist in South Africa and the development of new industries will create a big and steady demand for equipment of all kinds. Chemical engineering equipment in particular will have to be built. Evaporation and distillation equipment, filter presses, scrubbing equipment, and similar apparatus are required in all industry. Equipment such as this is of special design and construction and requires for its manufacture a staff of technical men versed in this particular field and skilled operators under their direction.

In the case of complete plant, too, steam-power plants, waterworks, pumping installations, pipe-lines, complete industrial plants such as sugar-mills, flour-mills, and chemical plants, the manufacturer who is on the spot and is able to design to suit peculiar local conditions will be in a far better position than competitors who do not cater especially for South African requirements. With steel available locally, and a demand for industrial apparatus, there is required the experience of years, which overseas manufacturers possess, to connect up the two and establish this very important industry—the manufacture of industrial equipment.

South Africa is already an important agricultural and pastoral country. She is a large producer of maize, sugar, fruit, wool, and hides and skins, and bids fair to become one of the foremost beef and cotton producing countries of the world. There is already a large market for agricultural implements and machinery, and with steel available, all these can be made and sold in South Africa.

For numerous other manufactured articles in this field there is a large market in South Africa. The statistics of imports appended to this chapter give details of all these articles, and indicate the possibilities of development.

The Iron and Steel Industry Encouragement Act, 1922.

Following the lines of a report submitted by the Board of Trade and Industries in June, 1922, this Act (No. 41 of 1922) makes provision for the payment, out of the Consolidated Revenue fund, of bounties in respect of pig-iron and steel produced in the Union from ores mined in the Union. These bounties are to be paid only if the plant is capable of producing at least 50,000 tons of pig-iron or steel per annum. Advances, if desirable, may be made to the producer prior to the stage of production having been reached, provided that these advances do not exceed in any one year the amount of bounties which would be obtained if the stage of production had been reached. Every producer desirous of obtaining a bounty under the Act must notify the Minister of Mines and Industries of his intention to commence production, and furnish particulars of the company and the plant. The Act further provides (1) for the nomination by the Governor-General of a representative on the board of directors of any company receiving a bounty; (2) for the examination of the books and accounts of any producer desirous of obtaining a bounty; and (3) for the preparation by the Treasury of annual returns of particulars of bounties paid.

The schedule to the Act sets forth the rates at which the bounties are to be paid, as shown in the following table:—

IRON AND STEEL BOUNTIES.
(Act No. 41 of 1922.)

Financial Year.	Per Ton of Pig-iron or Steel Produced.
	s. d.
1924–25	15 0
1925–26	15 0
1926–27	15 0
1927–28	12 6
1928–29	10 0
1929–30	7 6
1930–31	5 0
1931–32	2 6

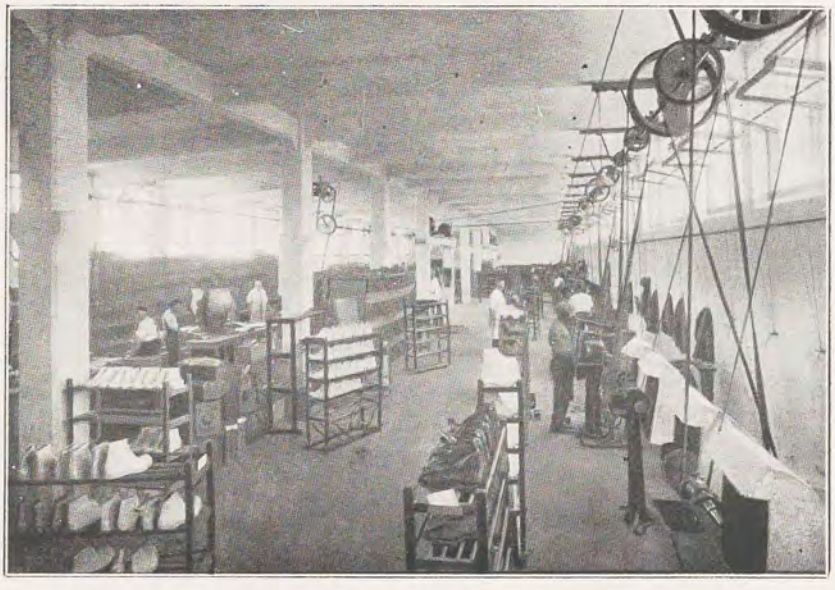
IMPORTS OF IRON AND STEEL GOODS, 1924.

	Quantity.	Value.
	Cwt.	£
Anchors and chain cables for ships' use	850	1,076
Angle, channel, and T	128,496	57,383
Bar, bolt, and rod	423,168	333,655
Cast iron (including rough and finished; not pipe fittings)	950	2,102
Chains for hauling	23,190	38,974
Girders, beams, joints, columns, and structural shapes	11,569	10,254
Hoop	33,368	26,149
Pig and ingot	58,296	14,774
Pipes and piping, cast-iron and steel	143,167	94,622
Pipes and piping, wrought-iron and steel	435,544	472,707
Pipe fittings	16,392	30,530
Plate, rolled	340,747	148,965
Galvanized, not corrugated	191,717	180,390
Galvanized and corrugated	753,991	643,695
Plate, tinned	105,329	122,295
Sheet, rolled, N.O.D.	53,633	36,980
Agricultural implements, machinery, and tools—		
Hoes and picks, kaffir	416,003	19,099
Dairy utensils	—	45,065
Hay presses	—	7,930
Ploughs, harrows, and parts	—	550,997
Reaping and mowing machines	—	92,159
Tractors, agricultural	167	31,602
Wine presses and pumps	—	1,993
Other (including agricultural machinery, N.O.D.)	—	57,973
Mechanics' tools	—	153,118
Pickaxes	—	143,173
Shovels	—	390,845
Machinery—		
Agricultural air compressors	—	15,411
Boilers	—	78,491
Cranes	—	21,964
Elevators and lifts	—	25,315
Engines, traction, and steam rollers	—	4,825
Engines, fire, and appliances	—	20,559
Engines, oil, petrol, and spirit	—	56,622
Engines, other	—	49,618
Fire-bars	—	191
Fruit driers and evaporators	—	3,582
Machine tools	—	50,683

THE FISHERIES, MOSSEL BAY.

WHALING, DURBAN.

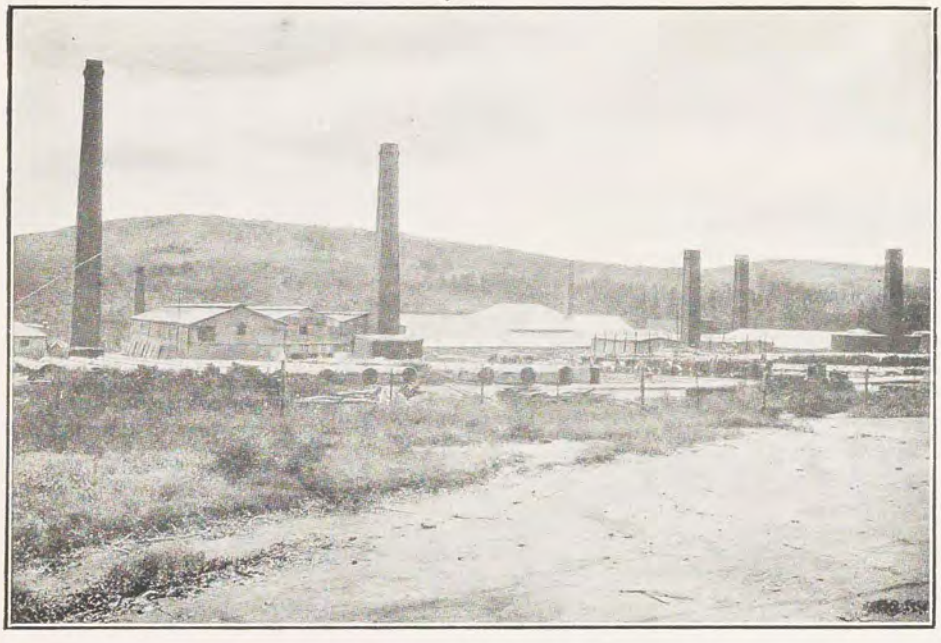
THE MAIN WORKROOM AT MESSRS. BAGSHAW, GIBAUD & CO.'S BOOT AND SHOE FACTORY, PORT ELIZABETH.



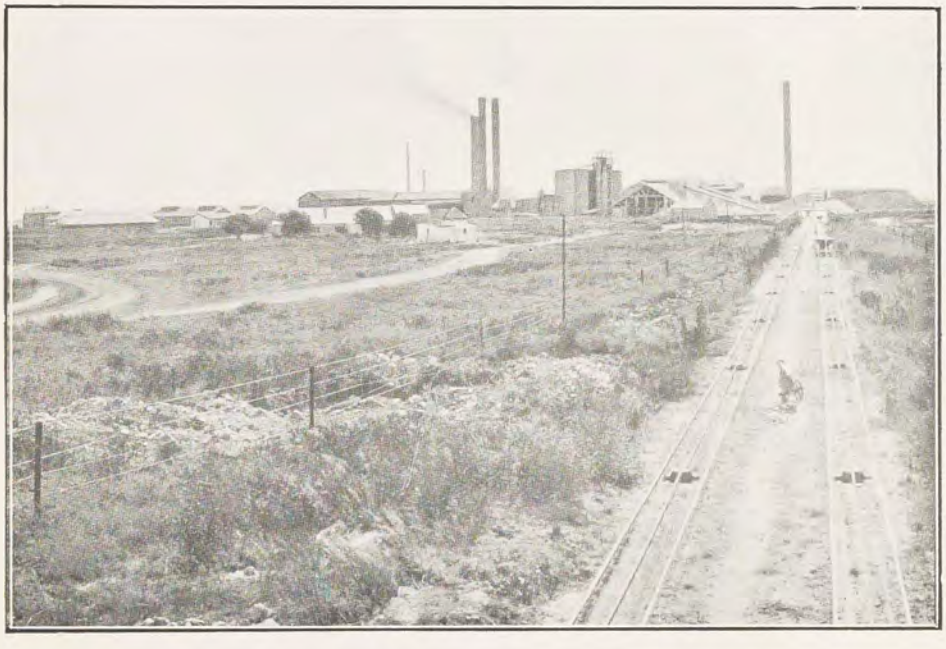
A VIEW OF THE MAKING-ROOM AT MESSRS. MOBBS' FACTORY, PORT ELIZABETH.

ELANDSBERG COAL HORIZON. (Pivaan Coal and Oil-shale.)

ESCARPMENTS OF BERG—IMPENDHLE OIL-SHALE HORIZON.



Brick and Tile Works, Groenkloof, Transvaal.



Pretoria Portland Cement Company Works, Slurry, Transvaal.

	Quantity.	Value.
Machinery (*contd.*)—	Cwt.	£
Manufacturing, confectionery making....	—	29,032
Manufacturing, corn and flour milling...	—	39,588
Manufacturing, others	—	29,549
Mining.....	—	871,280
Mining buckets and tip trucks.....	—	97,140
Packing, engine.....	—	46,952
Printing and bookbinding.....	—	158,768
Pumps.....	—	105,000
Sawing.....	—	11,747
Tanks and vats.....	—	6,092
Water-boring.....	—	20,076
Windmills.....	—	97,790
Wool presses.....	—	4,461
All other machinery, N.O.D.....	—	233,699

EXPORTS OF IRON AND STEEL GOODS (SOUTH AFRICAN MANUFACTURE), 1924.

	Chief Countries.	Quantity.	Value.
		Cwt.	£
Angle, channel and T	Africa.....	427	470
Barb, belt, and rod, including pig and ingot	,, ...	724	687
Castings.....	,, ...	130	211
Girders, beams, and joists	,, ...	20	26
Pipesandpiping	,, ...	49	111
Machinery—			
Manufacturing	African Territories	—	53
Mining.....	,,	—	1,684
Packing and lagging	,,	—	90
Printing.....	,,	—	15
All other, N.O.D.	United Kingdom, Africa	—	2,380

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CHAPTER XIX.

THE MINERAL WEALTH OF THE UNION.*

NOTE.—*In the space allotted to this chapter it is obviously impossible to give more than the merest outline of the subject, but it is hoped that the references given under each heading to the published literature on the subject will give any reader who wishes to carry his inquiries further, access to the information which he desires*

CONTENTS.

I.—Historical and General.

A.—HISTORICAL.

THOUGH South Africa is one of the oldest colonies of Europe, the history of the discovery and development of its mineral wealth is surprisingly short, shorter even than that of Australia. If the history is short, however, the developments as a whole have been of such stupendous magnitude that they rival the tales of romance, and the effect of them has been felt from one end of the world to the other. In detail, though no local Bret Harte or Fenimore Cooper has chronicled the romances of individual human life and fortune, these have at

* By Tudor G. Trevor, A.R.S.M., Inspector of Mines, Pretoria, brought up to date by the staff of the Mines Department.

least rivalled those of Australia, California, or the Klondyke.

Up to the year 1863 not one mining company was registered in South Africa, and until a much later date it was taught in the geography books that South Africa was destitute of minerals.

In the year mentioned (1863), the first mining company of which we have any record, was floated to work the Namaqualand copper mines. Since that date these mines (Cape Copper Company and the Namaqua Copper Company) have exported copper ore to the value of £20,265,000.

In 1867 the first diamond was discovered, a child having been found playing with it. From then to the present time the total output of diamonds has amounted, roughly, to 38 tons, valued in the rough state at £255,000,000. These diamonds were sold for that sum in the form in which they were found; at what value they passed into the hands of the wearers and the users it is impossible to estimate, and probably if the sum were doubled it would be below the mark.

(The above figure is in excess of that given in the returns of the Government Mining Engineer, but official statistics were not collected for the first ten years of the industry.)

Six years later, in 1873, gold was first won in the country. Thirteen years after that, in 1886, the Witwatersrand was discovered and Johannesburg founded. From the winning of the first gold in 1873 up to the end of the year 1926, the total value of the gold recovered amounted to £920,000,000.

Since the discovery of the Witwatersrand in 1886, deposits of coal, tin, copper, lead, and all the other minerals mentioned later in this chapter have been opened up, and in the sixty odd years which have elapsed since the opening of the first mine in 1863, the total value of the minerals won has been over £1,280,000,000. The annual value of the whole mineral output of the Union is now in the neighbourhood of £54,000,000, and it may remain in that neighbourhood indefinitely, for, although there will be a gradual decrease in the production of gold from the Rand, the development of the iron, coal, platinum, and other mines is likely to compensate for the loss.

South Africa therefore, in a period of some sixty years, has advanced from the position of a country in which there were no known minerals of economic value to that of the foremost diamond and gold producing country of the world, and is now beginning to develop her other mineral resources. It appears not improbable that the exploitation of these may be just as remunerative, if not as sensational, as any developments which have taken place in the past.

There are four sections of the community to whom the mining prospects of a country make special appeal:—

(1) The capitalist desirous of investing money in developing large mining propositions.
(2) The industrialist anxious to obtain certain mineral products for his industries.
(3) The adventurer seeking scope for his energies in the exciting gamble of prospecting and mining on a small scale.
(4) The employee seeking remunerative work.

To each of these the prospects of the future in the Union of South Africa are excellent, for every year brings forth some new discovery of unknown possibilities, and the old Roman adage that "out of Africa always comes something new" is as true to-day as on the day it was first spoken.

For the first section there are still unworked stretches of the Far East Rand awaiting development, while the iron and steel industry, and the coal trade in all its branches, are awaiting their Cecil Rhodes to organize them, to say nothing of the base and non-metallic minerals, to none of which the

serious attention of capital has yet been directed.

To the second section it may be pointed out that almost every known mineral of economic importance has been found in the Union, and that given a demand for these it is probable that nearly all of them can be produced in commercial quantities at economic prices.

To the third section the country is as attractive as it ever was. New mines are constantly being discovered, and fortunes are still being made by the individual workers of small mines.

The fourth section need only look at the statistics of labour and wages paid on the mines, which are given later in this chapter, to judge of the position.

B.—General Position Attained by the Mines.

(For full details see Annal Reports of the Government Mining Engineer and the *Union Year Book* No. 8, pp. 483–536.)

The following table gives the general mineral production of the Union from 1919-25 and shows the variety of the minerals produced, with their tonnage and value, which in the year 1926 reached a gross total of £58,694,781.

MINERAL PRODUCTION OF UNION, 1919–26.

(a) *Quantity.*

Classification.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Antimony..... ton	32	—	—	—	—	—	—	—
Arsenic..... „	8	11	2	3	6	106	34	8
Asbestos..... „	3,932	7,112	5,122	4,389	8,393	7,241	10,168	14,097
Bismuth..... „	0.4	—	—	—	—	—	—	—
Chrome ore..... „	—	—	400	96	—	2,056	12,474	14,980
Coal..... „	10,266,135	11,473,464	11,396,905	9,734,313	11,917,036	12,491,905	12,999,666	13,734,463
Coke..... „	22,478	22,942	24,954	40,591	59,250	74,101	79,560	87,099
Copper..... „	4,885	10,880	158	706	9,459	9,959	9,962	9,235
Corundum..... „	179	261	123	2,024	2,815	1,868	1,832	5,996
Diamonds....met. car.	2,656,651	2,612,511	828,036	669,559	2,053,095	2,440,398	2,430,128	3 217,967
Flint..... ton	*	*	*	*	*	*	*	*
Gold.....fine oz.	8,331,651	8,158,455	8,128,710	7,009,858	9,149,073	9,575,040	9,597,592	9,954,762
Graphite..... ton	86	73	47	42	60	55	52	51
Gypsum..... „	*	*	*	*	6,419	10,162	7,978	12,554
Iron ore..... „	3,602	2,564	2,416	2,109	574	—	—	52,029
Iron pyrite..... „	5,532	3,469	4,353	3,139	3,269	2,589	2,769	2,698
Kaolin..... „	—	—	—	20	33	—	—	—
Lead..... „	756	580	212	4,453	5,659	5,214	2,470	375
Lime..... „	106,004	119,797	113,325	98,452	114,605	110,521	110,562	†
Magnesite..... „	1,024	1,419	1,452	1,060	1,367	2,012	2,010	2,013
Manganese..... „	155	67	303	141	433	584	501	647
Mica..... „	3	1	1	4	16	810	1,612	961
Mineral paints.... „	240	536	117	293	239	317	—	303
Nickel..... „	—	—	—	—	—	—	—	—
Osmiridium..... oz.	—	—	510	762	1,784	4,107	6,055	6,360
Platinum..... „	—	—	—	—	—	—	—	4,951
Salt..... ton	85,175	88,861	68,379	83,562	68,531	77,569	65,333	†
Silver.....fine oz.	891,304	892,593	830,329	1,115,676	1,373,930	1,396,943	1,161,470	981,333
Soda..... ton	52	—	312	127	96	930	1,233	2,069
Sulphate of Ammonia „	3,762	1,844	918	207	509	1,097	948	1,023
Talc..... „	757	682	413	341	355	565	66	84
Tar..... gall.	1,465	25,167	46,085	80,462	179,187	186,171	172.854	385,742
Tin..... ton	1,630	2,463	1,425	612	1,424	2,051	1,939	1,791
Tungsten..... „	4	—	—	—	—	—	—	—
Zinc..... „	—	2,349	1,280	—	—	—	—	—

* Included in "Quarry products." † Figures not yet available.

MINERAL PRODUCTION OF THE UNION, 1919–26—(*continued*).

(b) *Value.*

Classification.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
	£	£	£	£	£	£	£	£
Antimony	556	—	—	—	—	—	—	—
Arsenic	663	655	120	105	290	4,260	790	122
Asbestos	66,426	114,195	103,067	81,230	121,453	110,075	152,115	216,466
Bismuth	300	—	—	—	—	—	—	—
Chrome Ore	—	—	400	108	—	2,446	21,001	14,623
Coal	3,416,244	4,519,665	5,072,401	3,395,176	3,713,706	3,824,746	3,862,118	4,046,620
Coke	47,312	48,535	51,180	57,758	76,294	90,537	92,643	106,153
Copper	234,445	418,269	6,446	38,622	404,511	530,824	514,219	494,852
Corundum	1,486	1,446	770	15,492	22,543	13,284	13,229	44,871
Diamonds	11,734,495	14,762,899	3,103,448	2,266,631	6,038,207	8,033,406	8,198,128	10,683,597
Flint	*	*	*	*	*	*	*	*
Gold	39,279,590	45,605,764	43,082,162	32,343,485	41,574,945	44,739,377	40,767,981	42,285,139
Graphite	2 630	2,339	1,496	1,250	1,837	1,597	1,510	1,575
Gypsum	*	*	*	*	*	*	*	*
Iron ore	1,081	811	689	893	230	—	—	16,958
Iron pyrite	8,894	5,014	6,632	4,714	4 906	3,109	3,400	3,376
Kaolin	—	—	—	20	40	—	—	—
Lead	4,973	5,270	3,363	94,720	133,573	153,288	55,966	5,726
Lime	201,958	244,745	255,186	209,720	239,992	215,634	216,103	†
Magnesite	2,723	3,780	3,581	2,372	2,943	4,159	4,007	4,211
Manganese	776	277	866	246	1,584	1,300	817	744
Mica	369	500	802	664	1,038	2,296	4,577	2,969
Mineral paints	572	1,049	333	636	468	634	—	607
Nickel	—	—	—	—	—	—	—	—
Osmiridium	—	—	6,801	13,165	43,528	102,886	170,995	96,734
Platinum	—	—	—	—	—	—	—	93,307
Salt	193,067	197,068	162,918	148,445	114,225	111,459	105,969	†
Silver	228,804	245,871	137,441	171,427	197,888	212,470	166,898	126,580
Soda	753	—	4,527	1,588	1,018	9 844	13,480	22,970
Steatite	*	—	*	*	*	*	*	*
Sulphate of Ammonia	102,930	63,088	19,470	3,046	7,531	12,987	11,920	10,680
Talc	2,170	2,227	1,306	1,023	1,065	1,592	262	385
Tar	135	3,382	5,104	3,621	8,597	9,180	8,441	15,466
Tin	277,925	435,680	139,688	59,986	170,337	305,398	304,552	310,899
Tungsten	699	—	—	—	—	—	—	—
Vanadium	—	—	—	—	2,716	—	—	—
Zinc	—	15,614	8,410	—	—	—	—	—
Miscellaneous Articles (bricks, cement, earthenware pipes, etc.)	1,079,126	1,558,337	2,010,786	1,555,226	1,644,105	1,974,205	1,765,162	†
Quarry products	68,275	75,647	78,693	56,032	100,922	172,215	105,248	89,151
TOTAL.....£	56,959,377	68,332,127	54,268,086	40,527,401	54,630,492	60,643,208	56,561,531	58,694,781

* Included in "Quarry products." † Figures not yet available.

C.—COMPANIES AND CAPITALIZATION.

In 1926 there were 326 public mining companies, capitalized at £82,127,000, employing 39,029 white men and 305,589 coloured persons. These companies paid in 1926 £12,534,046 in dividends. In the same year they distributed in wages £10,103,254 to white employees and £8,798,417 to coloured employees. The value of the stores consumed by the mines and their nature is given in Table I, the total value being over £16,995,609.

VALUE OF STORES CONSUMED, UNION OF SOUTH AFRICA, YEAR 1926.

	Gold Mining Industry.	Diamond Mines.	Coal Mines.	Other Mines.	Works (Lime, Flint, and Gypsum).	Total.
	£	£	£	£	£	£
Witwatersrand..... £13,381,409 Outside Witwatersrand.... 562,792 Total Large Gold Mines 13,944,201 Small Gold Mines..... 54,899 Alluvial Diggers..... 7,047 Metallurgical Works and Old Tailings and Reduction Sites..... 29,769					Compilation of these figures is discontinued.	
TRANSVAAL.....	14,035,916	213,032	552,492	673,876		15,475,316
CAPE.....	.	483,617	486	105,781		589,884
ORANGE FREE STATE.....	38	284,577	63,316	.		347,931
NATAL.....	763	.	569,610	12,105		582,478
UNION OF SOUTH AFRICA....	**14,036,717**	**981,226**	**1,185,904**	**791,762**	.	**16,995,609**
Year 1925.....	13,766,387	852,583	1,153,106	463,922	.	16,235,998
Year 1924.....	13,778,679	746,542	1,222,248	349,513	.	16,096,982
Year 1923.....	13,425,200	722,270	1,211,094	336,156	.	15,694,720
Year 1922.....	11,126,393	448,731	1,180,593	244,327	.	13,000,044
Year 1921.....	14,439,837	917,268	1,854,205	347,548	.	17,558,858
Year 1920.....	14,363,651	1,483,284	1,597,376	398,999	.	17,843,310
Year 1919.....	13,208,449	1,058,050	1,301,570	333,207	.	15,901,276
Year 1918.....	12,983,470	747,142	1,083,905	362,385	90,968	15,267,870
Year 1917.....	12,704,839	688,801	996,242	453,398	79,985	14923,265
Year 1916.....	12,320,502	360,485	798,611	448,037	67,623	13,995,258
Year 1915.....	10,935,383	139,521	617,819	343,150	46,498	12,082,371
Year 1914.....	10,277,087	969,325	643,158	291,879	43,086	12,224,535
Year 1913.....	10,633,152	1,645,219	643,256	395,504	45,774	13,362,905
Year 1912.....	10,311,940	1,466,151	523,025	307,135	51,796	12,660,047
Year 1911.....	11,714,755	1,450,127	544,782	305,830	55,614	14,071.108

Stores used on Alluvial Diamond Diggings and on Quarries are not included in this statement, as no reliable information is available.

D.—WAGES.

The rate of wages drawn by the employees on the mines of the Witwatersrand is given in the following table (in other districts and in other industries the wages are slightly less, but the controlling factor in the determining of them is the rate paid on the Rand):—

AVERAGE PAY PER SHIFT, UNDERGROUND MINE EMPLOYEES ON WITWATERSRAND GOLD MINES (JUNE), 1920–26.

Classification.	1920.*	1921.*	1922.*	1923.*	1924.*	1925.*	1926.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Shift bosses	35 1	35 11	30 6	30 4	30 6	30 2	30 5
Timbermen	29 4	29 4	21 5	21 11	22 0	22 0	22 8
Pipemen	28 6	28 8	20 5	20 7	20 10	20 9	21 6
Fitters	30 7	30 10	22 10	22 10	23 5	24 1	24 1
Platelayers	28 6	28 8	20 5	20 7	20 10	20 9	21 6
Skipmen and onsetters	25 4	25 9	16 6	16 10	17 3	17 3	17 8
Trammers (excluding contractors)	25 11	25 10	17 8	18 2	17 9	18 6	18 9
Pumpmen	29 0	29 0	20 3	20 1	20 0	20 3	20 9
Miners—Machine stoping—Contract	47 4	49 10	30 4	29 11	29 9	29 5	29 8
Day's pay	27 4	33 5	21 0	21 1	21 4	20 6	21 7
Hand stoping—Contract	40 6	41 8	28 4	26 9	26 10	27 0	26 9
Day's pay	28 6	28 9	19 10	20 5	20 3	20 3	21 0
Machine developing—Contract	56 2	61 7	38 10	40 1	38 11	38 6	40 3
Day's pay	33 5	31 5	21 3	20 4	20 4	20 8	22 10
Shaft sinkers—Contract	65 0	68 1	35 1	47 9	56 8	58 2	65 0
Day's pay	45 4	46 0	22 11	25 0	43 5	24 6	20 4
Engine-drivers (winding)	31 2	32 4	23 7	24 10	24 2	25 0	24 8
Winchdrivers	24 2	23 11	16 3	16 8	15 4	14 9	16 3

* Including allowances but excluding overtime.

E.—NATIONALITY OF EUROPEANS.

The nationality of Europeans employed on the mines in 1926 was as follows:—

	Per Cent.
Born in South Africa	58.5
Born in the United Kingdom	36·8
Born in other British Dominions	2·0
Foreigners	2·7

F.—ACCIDENT DEATH-RATE.

The death-rate from accidents in the coal mines of Great Britain in 1924 was 0.98, and the same rate for all mines. In the United States of America in 1924 it was 2.87 for coal mines, and for metal mines was 2.98 in 1923.

The following table gives accidents and death-rates on the South African mines from 1911 to 1925:—

ACCIDENTS AND DEATH-RATES ON MINES FROM 1911.*

Year.	Total Number of Accidents.	Fatal Accidents.	Deaths during the Year.	Death-rate per 1,000 Employees.			
				Metalliferous Mines.	Coal Mines.	Diamond Mines.	All Mines.
1911	2,897	882	1,061	3·89	1·96	2·24	3·51
1912	3,027	785	987	3·65	2·11	1·48	3·22
1913	3,200	793	992	3·57	2·88	2·24	3·31
1914	2,631	593	743	3·09	1·90	1·55	2·80
1915	2,552	608	776	3·05	2·05	0·40	2·93
1916	2,769	635	808	2·99	2·05	0·67	2·79
1917	2,631	545	664	2·53	2·16	1·10	2·37
1918	2,651	498	612	2·43	1·60	1·19	2·23
1919	2,945	516	607	2·36	1·83	1·88	2·25
1920	3,314	550	613	2·34	2·41	0·92	2·21
1921	4,947	434	525	2·14	1·65	1·06	2·03
1922	3,361	361	437	1·83	2·41	0·53	1·88
1923	3,913	504	637	2·44	2·70	1·29	2·42
1924	4,321	524	667	2·49	2·31	2·34	2·45
1925	4,826	506	600	2·27	2·35	1·15	2·21
1926	4,753	535	735	2 13	5·69	1·27	2·54

* Excluding Alluvial Diamond Diggings.

G.—HEALTH.

The general health, both of the employees, their families, and of the general population on all the mines and the mining towns in the Union, is, without exception, excellent.

H.—SILICOSIS.

(See Reports of the Miners' Phthisis Board and Miners' Phthisis Medical Bureau, 1916-24. Cape Times, Ltd., Government printers, Capetown.)

The special question of miners' phthisis or silicosis has been worked out in a manner in which probably no other health problem in the world, except that at the construction of the Panama Canal, has been dealt with. From 1911 to April, 1926, this subject has cost the mines and the Government £8,151,951 in direct compensation to suffers, while the amount spent underground on preventive measures has been probably very much greater.

As the result of an enormous amount of scientific labour and research the question is now better understood locally than anywhere else in the world; indeed, though there are still some interesting scientific points to be settled, from a practical standpoint the disease is completely in hand. The mines are divided into two classes—those which produce silicosis and those which do not; all the diamond and coal mines and most of the smaller gold and base metal mines are included in the latter class. In the phthisical mines of the first class no man may be engaged until he has passed a stringent medical examination conducted by the Miners' Phthisis Medical Bureau. Having been accepted for work, every man is subject to periodic examination by the Board for symptoms of silicosis. The stages of the disease are divided into four—anti-primary, primary, secondary, and tertiary. It has been established that anti-primary symptoms do not develop into any future trouble if the patient is removed from further chances of inhaling dust. On the periodic examination disclosing anti-primary symptoms, workmen are discharged from phthisical mines, and are not allowed to be re-engaged for underground work on them, but they receive in compensation a sum of £350.

I.—LIVING CONDITIONS AND AMENITIES OF LIFE ON THE MINES.

On all the mines accommodation is either provided or is easily procurable. The standard of life for employees is pitched on a very much higher level than on the mines in Europe, and is comparable with that of the model villages for employees established at Port Sunlight or at the works of Messrs. Cadbury in England.

J.—MINING LAWS, ETC.

The mineral laws of the Union of South Africa have not yet been consolidated, and are of too complicated a nature to be dealt with in this publication. Inquiries are therefore directed to the *Union Year Book*, pages 618 *et seq.* of the sixth issue, and to Volume III of "The Mining Laws of the British Empire," published by the Imperial Bureau of Mineral Resources, London, 1922.

II.—Detailed Position of the Production of Various Minerals.

The foregoing paragraphs having given the general position of mining in the Union, the following is an abbreviated account of the position with regard to each industrial mineral known to occur in commercial quantities:—

A.—GOLD AND DIAMONDS.

(See Reports of the Government Mining Engineer, *Union Year Book*, pages 581 *et seq.*)

The diamond and gold mining industries of South Africa are so thoroughly established and based on such reliable and permanent deposits that in the gross their future development does not offer any great interest to the industrialist. The development

of these industries is an accomplished fact, and whatever future extensions there may be, may safely be left in the competent hands of the present controllers of the industries. The industrialist can, with safety, reckon on the output and therefore the purchasing power of these industries remaining very much at its present level for many years to come. This purchasing power is, however, of the utmost importance to any one investing money in South Africa, as by the purchase of necessities these mines supply a constant and remunerative local market for an enormous variety of products, nearly all of which have in the past been imported from overseas, but facilities for the manufacture of which undoubtedly exist in the country and only await the enterprise of capital. Table I, at the end of this chapter, which gives a detailed list of the stores purchased by the mines and their values, illustrates this point of view.

In view of the above statement, the following account of the established diamond and gold mines of South Africa is very much abbreviated, but those seeking fuller details can find them in the literature to which reference is given both at the head of this section and in the bibliography attached to this volume.

(a) *Gold.*

Witwatersrand Gold Mining.—The Witwatersrand goldfields are located on an elevated plateau nearly 6,000 feet above the sea. The Witwatersrand (or white-waters-ridge) projects somewhat above the plateau, and the outcrop of the Witwatersrand formation is for some distances the watershed between the Atlantic and Indian Oceans, the tributaries of the Vaal River draining into the Atlantic, and those of the Limpopo or Crocodile River into the Indian Ocean.

The conglomerate beds of the Witwatersrand are composed of quartz pebbles bound together by a siliceous cement containing iron pyrites. The name "banket" has been given to the conglomerate from its general resemblance to an almond sweetmeat with this Dutch name, which, however, refers specially to the ore taken from the oxidized zone, which in the early history of the fields was called "free milling" and was found to extend to only a limited depth. The bankets occur in a series of quartzites and shales, which are known as the Witwatersrand beds, and which constitute a formation succeeding in age the Moodies Series of Barberton.

The gold contained in the conglomerate is not often visible to the naked eye, occurring almost invariably in the matrix, its existence in the pebbles having been recognized only in rare instances. The gold is, for the most part, in very fine particles, and when examined under the microscope shows sharp crystalline structure, giving no evidence of being rounded and moulded by attrition, as is observable on examination of most gold found in alluvial deposits. There are several series of these conglomerate beds in planes more or less parallel to each other. The most common designation of them, starting from the lowest geological horizon, is as follows: Government Reef, Main Reef Series, Bird Reef, Kimberley Series, and Elsburg. Gold is found as a constituent in all the banket beds included in the foregoing list, but thus far the Main Reef Series only has justified extensive exploitation, and even here only within certain limits.

Improved mechanical methods and labour organization have gradually brought all the chief gold mines to a similar basis as regards both mining and metallurgy, and a very satisfactory extraction is obtained. The success in working these large bodies of comparatively low-grade ore may be assigned to the following causes:—

(*a*) The adaptability of the cyanide process to the Witwatersrand ores.

(*b*) The uniformity and character of the gold-bearing deposits.
(*c*) Cheap unskilled labour.
(*d*) The proximity of coal deposits.
(*e*) Absence of heavy pumping charges.
(*f*) Good water supply.

Actual mining on the main gold-bearing area is greatly assisted by a very strong roof which supports all excavations made within reason and which requires a minimum of timbering and other supports. This excellent roof or hanging-wall has its limits, however, and the enormous amount of ore extracted during the past thirty years is beginning to have effect over large worked-out areas, causing large falls, earth tremors, and subsidences, and necessitating extensive sand-filling and other precautions to save existing workings and communication ways.

Gold Production (Reef).—The following table shows the progressive reef gold production of the Transvaal, which in 1926 contributed approximately 52 per cent. of the world's gold output:—

QUANTITY AND VALUE OF GOLD PRODUCED IN TRANSVAAL FROM 1884 TO 1926.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Fine Oz.	£		Fine Oz.	£
1884	2,376	10,096	1905	4,908,087	20,848,273
1885	1,414	6,010	1906	5,792,823	24,606,336
1886	8,171	34,710	1907	6,450,740	27,400,992
1887	39,880	169,401	1908	7,056,266	29,973,115
1888	227,749	967,416	1909	7,295,108	30,987,650
1889	350,909	1,490,568	1910	7,527,108	31,973,123
1890	440,152	1,869,645	1911	8,249,461	35,041,485
1891	688,439	2,924,305	1912	9,107,512	38,686,250
1892	1,069,058	4,541,071	1913	8,798,336	37,372,949
1893	1,200,218	5,480,498	1914	8,394,322	35,656,814
1894	1,805,000	7,667,152	1915	9,093,902	38,628,437
1895	2,017,443	8,569,555	1916	9,296,618	39,489,522
1896	2,025,510	8,603,821	1917	9,018,084	38,306,381
1897	2,743,518	11,653,725	1918	8,418,292	35,758,636
1898	3,823,367	16,240,630	1919	8,331,294	†35,389,091
*1899	3,637,713	15,452,025	1920	8,158,226	†34,635,947
*1900	348,761	1,481,442	1921	8,128,681	†34,528,443
*1901	258,307	1,097,219	1922	7,009,767	†29,775,598
*1902	1,717,944	7,297,351	1923	9,148,771	†38,861,511
1903	2,971,416	12,621,781	1924	9,574,918	†40,671,667
1904	3,770,963	16,018,026	1925	9,597,573	†40,767,901
			1926	9,954,762	42,285,139

* War period. † Not including premium.

In the early days of modern mining, accurate statistics were seldom available, but the total production of gold from the Union of South Africa from 1868, when gold was first discovered, to the end of 1926, amounts approximately to £918,707,885 including the premium, and the gold was practically all won in the Transvaal.

Methods of Mining.—The gold-bearing beds of the Witwatersrand are locally known as reefs. They are beds of conglomerate occurring in a pre-Cambrian sedimentary formation and strike east and west and dip south. Speaking generally, the reefs are steep at the outcrop, flatten in depth, and again steepen somewhat in the deeper

workings. In the early days inclined shafts followed the reefs from the outcrop; as depths increased, either compound shafts in which vertical shafts connected directly with underground inclines, or auxiliary underground incline shafts provided with their own underground winding engines were adopted. Recently many deep vertical shafts have been put down, and in some cases greater depth is being reached by auxiliary underground vertical shafts. Practically all development is done by air-driven machines, and though a good deal of stoping is still done by hand, machines —especially those of the small "Jackhammer" type—are generally used in stopes. Some mines obtain their compressed air by purchase from a large central power-station, while many use electric power developed in four central stations for hoisting and other purposes. With the increase in area from which reef has been removed and the greater depth of working, the problem of securing safety from falls of rock has become more difficult, and systematic building of packs, either of stone alone or stone and timber to support the hanging-wall, has had to be undertaken.

To prevent miners' phthisis, extraordinary measures by installation and use of water services for dust-allaying have for some years been adopted, and recently increased attention has been given to the provision and distribution of ventilation as a means of diluting and removing the dust inevitably formed despite all precautions.

Metallurgy of Gold Production.—The process of extracting the metal from the ore raised from the mines may be summarized as follows: In the first place, the valueless rock is sorted or picked out on picking belts or tables. The gold-bearing rock is then reduced to smaller size in jaw or gyratory stone-breakers, crushed finer in stamp mills and still finer in tube mills. There are two methods in vogue of catching the coarser free gold. The one is by means of copper plates treated with amalgam, and the other by means of corduroy tables. In the former the fine ore is carried in a stream of water, either directly from the stamp mills or from the tubes mills, over mercury coated copper plates. In the latter, the concentrates are caught on tables covered with corduroy. These concentrates are further concentrated over shaking tables. The product of this is amalgamated in amalgam drums with mercury.

In both cases the gold is obtained from the amalgam by distilling off the mercury in a retort and smelting the resulting gold "sponge." The coarser sand is separated from the finer "slime" in hydraulic classifiers, and the gold is extracted from the "sand" by "leaching" in vats with cyanide solution. The gold is precipitated on zinc shavings or occasionally zinc dust and recovered by treating it with sulphuric acid, the resulting gold "slime" being filter-pressed, calcined, and smelted. The gold is extracted from the "slime" by agitation with cyanide solution, decantation or filtering and precipitation on zinc, as in the case of the solution from "sand."

The tendency is to attach greater importance to the tube-milling and slime treatment, and in the most recently designed plants it is proposed to eliminate the stamp mill and the amalgamation process, and to extract gold only by cyanide treatment of the "slime" to which all the ore will be reduced.

Barberton Goldfields.—The Barberton goldfields date from 1885, when the phenomenally rich Sheba mine was discovered. The geological formation is that of the Moodies Series of sedimentary rocks, which are included in the old granites and from the most ancient sedimentary deposits known in South Africa. The gold occurs both in fissure veins, in interbedded quartz veins, and impregnations in the sedimentary quartzites. In all cases the

pay ore runs in chutes, which are often extremely rich at the surface, but are apt to become poor in depth. In some cases the ore is free-milling, but in others the gold is associated with iron pyrites, arsenic, and antimony. The Sheba mine produced in the thirty-three years of its existence (from 1885 to 1918) 952,715 ounces of gold, valued at £4,046,876, and is now being reopened. Owing to the fact that the gold occurs in the country rock with no obvious and visible pointer to its existence, it is difficult to discover the chutes, and though the district was very thoroughly prospected in the early days, new mines of exceptional richness, though of small size, continue to be discovered, and this will doubtless go on for many generations.

A full account of this district will be found in Memoir No. 9 of the Geological Survey of South Africa. "The Geology of the Barberton Gold Mining District," by A. L. Hall.

Pietersburg and Murchison Range.—As in Barberton, the gold mines of this district are situated in the rocks of the Moodies Series. The deposits are, however, very much smaller and more irregular than in the Barberton District, and though they have been known since the year 1870, their exploitation has been uniformly unsuccessful. For a full account of this district, see Geological Survey Memoir No. 6, "The Geology of the Murchison Range and District," by A. L. Hall.

Lydenburg and Pilgrims Rest.—The goldfields of this area have been successfully exploited for the past fifty years. At first Pilgrims Rest was an important alluvial goldfield, and it is the only portion of South Africa which ever gave good results as an alluvial digging. As the alluvial gold became worked out, its origin was traced to a number of interbedded quartz veins which lie at various horizons in the dolomite, which here makes the country rock of the district. In the main these mines have been successfully worked by large companies, but there are also a number of small quartz leaders and beds, sometimes of phenomenal richness, which support a considerable number of individual small miners, many of whom do extremely well for a period. The country here, lying on the edge of the great escarpment, is extremely attractive, and there are probably few places in the world where mining is carried out so successfully and under such ideal conditions as in this district, the output of which in 1926 was 108,609 fine ounces, valued at £461,340. Descriptions of this area appear in Memoir No. 5 of the Geological Survey of South Africa, "The Geology of the Pilgrims Rest Gold Mining District," by A. L. Hall, and in Memoir No. 23, "The Economic Geology of Sabie and Pilgrims Rest Goldfields," by W. Wybergh.

Alluvial Gold.—At the present date it cannot be said that there are any alluvial gold diggings in South Africa, although a few diggers still can be found prospecting the alluvial deposits in the Pietersburg, Barberton, and Pilgrims Rest Districts, for in 1926 the output of alluvial gold was only 500 fine ounces from all Transvaal districts. In 1873, and for some years following, a considerable quantity of so-called alluvial gold was won at Pilgrims Rest and Barberton Districts until the deposits were worked out and the diggers turned their attention to the gold-bearing reefs and beds. At the Duivels Kantoor the sandstones of the Black Reef Series contain alluvial deposits of small extent, and numerous nuggets of gold have been found in this locality. In 1898 a 52-ounce nugget was found on the main coach road near the Duivels Kantoor, and this nugget was shown at the Paris Exhibition in 1900. The gold from these fields has apparently been derived from the dolomites and other formerly overlying rocks, which have now disappeared through erosion.

Alluvial gold recovered in the Transvaal from the date of the British occupation up to the 31st December, 1925, amounts to 34,881 ounces of fine gold.

In the Cape Province, from 1910 to the 31st December, 1925, 299 ounces of fine gold were obtained. In Natal, from 1910 to the 31st December, 1925, 744 ounces of fine gold were obtained.

The total alluvial production of the Union to the end of 1925 was 35,570 ounces of fine gold.

Future Production.—The Union of South Africa is the premier gold producer of the world, and in 1925 contributed about 50 per cent. of the world's total gold output estimated at approximately 19,000,000 fine ounces.

Forecast of Witwatersrand Gold Mining Industry.—In a report by the Government Mining Engineer dated May, 1927, the decline of the producing mines on the Witwatersrand based upon the lives as determined for purposes of Income Tax was summarized as follows:—

	Tons.	Reduction per cent.
Crushing capacity end of 1926	29,831,000	—
Crushing capacity after 5 years	25,786,000	13·56
Crushing capacity after 10 years	14,457,000	51·54
Crushing capacity after 15 years	6,343,000	78·73

He qualified these figures by pointing out the conservative nature of estimates of lives for purposes of Income Tax, and expressed the opinion that these estimates could be extended by three years on the average. While considering that the downward trend in working costs justified a measure of optimism regarding the opening up of further mines in the most easterly portion of the Witwatersrand, and that the indications pointing to a prolongation of the life of the gold mining industry considerably beyond the periods shown by the official lives of existing mines are most favourable, he stated that no definite forecast of future production can be made.

The continuity of the Witwatersrand as a gold producer depends upon the practicability of mining at great depth and on the extension of the reef beyond the present proved areas. On account of the comparatively great strength of the formation and the low rate of increase of temperature with depth, it should be possible to mine at greater depths than have been attained hitherto in any part of the world.

The limits of deep mining are governed by many causes and have been variously estimated at from 6,000 feet to 10,000 feet. It appears reasonably certain that, owing mainly to the low-temperature gradient of 200 feet to 250 feet per degree Fahrenheit, mining can be carried on to a depth of at least 7,500 feet, where the grade of ore mined is sufficiently high to cover the high cost which must inevitably prevail at such a depth.

While unique in the extent of its resources the Witwatersrand must be looked upon as being on the average a low-grade goldfield, and, with only a few shillings per ton profit to work on, the question as to what companies can profitably continue to mine at great depths is inextricably bound up with the question of working costs, which is again largely dependent upon the supply and cost of labour.

Refinery and Mint.—An up-to-date refinery, the largest of its kind in the world, capable of dealing with the whole output of the country, has been established at Germiston, on the Witwatersrand, while a branch of the Royal Mint has been opened in Pretoria, and is already issuing silver currency and gold currency.

(b) *Diamonds.**

(See Wagner, P. A., "The Diamond Fields of Southern Africa," Hortors, Limited, Johannesburg, 1914; and C. E. B. Frood, *Official Year Book of the Union of South Africa*, No. 1, 1917, pp. 449-457.)

* By Percy A. Wagner, Geological Survey.

Notwithstanding recent discoveries elsewhere the Union of South Africa continues to be the leading producer not only of "mine" but of alluvial diamonds, having been responsible during 1925 for about 74 per cent. by value of the world's annual production of these the most sought after of all precious stones. If the output of South-West Africa were to be included, the percentage would have to be increased to 86.5.

Production since 1867, when the first find was made, amounts to roughly 32 tons, valued at over £255,000,000, and this notwithstanding, it is safe to assert that even if no new discoveries are made—which is unthinkable—the assured reserves are sufficient to keep the world supplied for the next hundred years or more.

The commanding position enjoyed by South Africa in comparison with other diamond-producing countries is shown by the following table giving the world's output of diamonds during 1925.*

	Weight. (Carats.)	Value. (Sterling.)	
		£	
Union of South Africa—			
Mines	2,190,871	6,291,510	
Alluvial Fields	239,257	1,906,618	
South-West Africa	515,000	1,400,000	
Belgian Congo without B.C.K.† Concession	305,000	600,000	
B.C.K. Concession, Belgian Congo (nearly all industrial diamonds of inferior quality)	580,000	300,000	
Angola	125,000	360.000	
Gold Coast and West Africa	100,000	100,000	
TOTAL	4,055,128	£10,958,128	
British Guiana	220,000	700,000	
Brazil, Borneo, Southern Rhodesia	—	200,000	estimated.
	—	£11,858,100	

Sales of "mine" diamonds from sources within the Union of South Africa amounted to 2,358,775 carats valued at £6,758,244, as against a production of 2,190,871 carats valued at £6,291,510. The surplus was derived from stocks of diamonds that had accumulated in the hands of producers during periods of depression. At present the market for good stones is buoyant, and it is anticipated that sales during 1926 will exceed those during 1925.

The Diamond Fields of Southern Africa.

The productive diamond fields of Southern Africa, including those of the Belgian Congo, Angola, and Southern Rhodesia are scattered over a vast area of the sub-continent between latitudes S. 5° and S. 31°. The diamond, as might be expected, is found under the most diverse conditions, the principal modes of occurrence being as follows:—

(1) In pipes and dykes of a peculiar porphyritic peridotite, known as

*Most of the figures given were kindly supplied to the writer by Sir Ernest Oppenheimer.
†Stands for Bas Congo Katanga Railway Company.

"kimberlite," which is always in a more or less advanced state of serpentinization. The "kimberlite" pipes are by far the most important source of production. They are deeply eroded volcanoes of the explosive type, occupied partly by serpentinized "kimberlite," partly by "kimlite" tuff and breccia, and partly by material derived from rocks pierced by the pipes. From the surface to a depth of from 35 feet to 140 feet the pipe-filling has generally been converted by hydration and oxidization into a soft, yellowish, clayey rock known as *yellow ground*. Below it follows a zone of hydrated, but not oxidized rock, which, from its peculiar greenish or greyish-blue colour, is known as *blue ground*. This, in turn, is succeeded by comparatively well-preserved "kimberlite," or *hardebank*, as it is termed on the mines.

While such pipes are scattered over an enormous area of the plateau tract of Southern Africa, the economically important occurrences are confined to a fairly well-defined diamond belt extending in a north-easterly direction from Jagersfontein, in the Orange Free State, to the Premier Mine, in the Transvaal, a distance of some 350 miles.

The most important pipes hitherto discovered are the Kimberley, De Beers, Bultfontein, Dutoitspan, and Wesselton, in and in the neighbourhood of Kimberley; the Jagersfontein and Koffiefontein, in the Orange Free State; and the Premier, east of Pretoria. Even in the most productive pipes the diamond constitutes but an exceedingly small part of the pipe rock. The tenor is generally expressed in terms of carats per 100 loads, a load being approximately 1,600 lb. In the occurrences at present being successfully worked, the yield ranges from 5.75 carats to 40 carats per 100 loads.

(2) In ancient conglomerates. Diamonds are found in the well-known auriferous conglomerates of the Witwatersrand; in conglomerates of upper triassic age at Somabula, Southern Rhodesia; and in the conglomerates of the Lubilache Series of the Belgian Congo and Angola, the geological age of which has not as yet been fixed. These occurrences, while of comparatively small importance from the point of view of production, are of great interest in showing that even in remote geological times the diamond must have been comparatively abundant in Southern Africa.

(3) In Tertiary and Recent stream gravels. To this category belong the extensive deposits in the basins of the Vaal, Harts, and Orange Rivers, and the even more extensive deposits situated in the basin of the Kasai River, in the north-eastern corner of Angola, and the adjoining areas of the Belgian Congo. In both areas stream and terrace gravels are worked, some of the gravels occurring at elevations of over 400 feet above the present river channels.

(4) In Pleistocene and Recent Marine conglomerates and gravels. Examples of this class of occurrence are the lately discovered deposits along the north-west coast of the Cape Province. They extend from the mouth of the Orange River as far, at least, as the mouth of the Groen River, a distance of 200 miles. The most productive occurrences are situated immediately south of the Orange near Alexander

Bay. They are of the nature of storm beaches. The Alexander Bay diamonds appear to have been carried down to the sea by the Orange River.

(5) In Tertiary conglomerates, grits and sandstones and eluvial gravels derived from their disintegration. The deposits in the coastal desert of South-West Africa, which have become so important a factor in the diamond industry, illustrate these types of occurrence. There has been a great deal of speculation regarding the origin of the South-West African diamonds. Recent investigations prove that in part, at any rate, they were brought down to the littoral by ancient rivers, in the gravels of which they became embedded. From these, through erosion, they found their way into miocene and later sediments accumulating along the coast, the distribution of the diamonds having probably been effected by the agency of the Benguella current. Upon the uplift of the coast these rocks were subjected to desert-weathering and in considerable part destroyed, a portion of the diamonds being thereby liberated and concentrated in residual surface gravels. The diamond has thus suffered several transportations and concentrations, with the result that some of the eluvial gravels are of fabulous richness.

Recently deposits apparently similar to those of South-West Africa have been found along the coast near Port Nolloth, in the Cape Province.

Diamond Mining.—For the exploitation of the "kimberlite" pipes and some of the productive dykes elaborate methods of open-cast and underground mining have been evolved. The deepest workings are at Kimberley, where mining operations have been successfully conducted at depths of over 3,500 feet. A description of these mining methods is beyond the scope of the present article, but will be found in the writer's work, "The Diamond Fields of Southern Africa."

The Winning of the Diamond.—The recovery of the diamond from the alluvial and eluvial gravels and from soft, decomposed "yellow ground" is comparatively simple owing to its high specific gravity. The treatment of the hard "blue ground" and "kimberlite," on the other hand, presents considerable difficulties, and the complex processes and plants now in use are the outcome of fifty years of practical trial and experience.

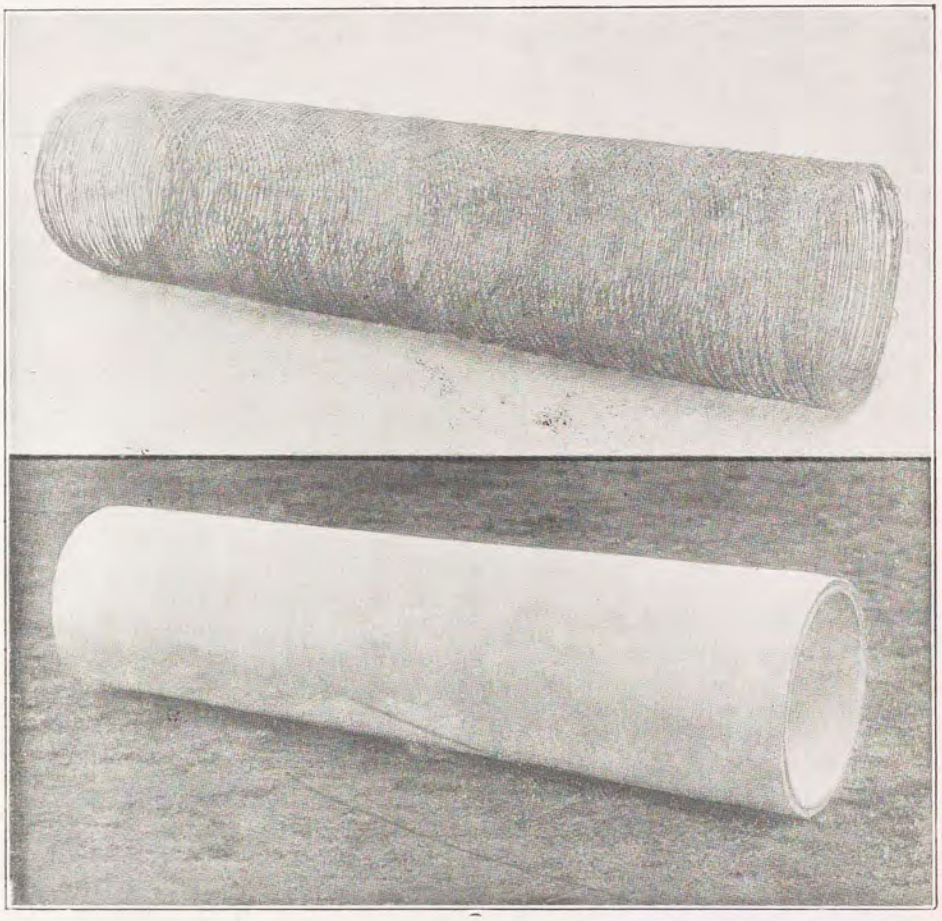
Treatment is generally carried out in three stages, namely:—

(*a*) Pulverization by natural or mechanical means, or by a combination of these processes, followed by preliminary concentration.

(*b*) Retreatment of the product thus obtained with a view to further concentration.

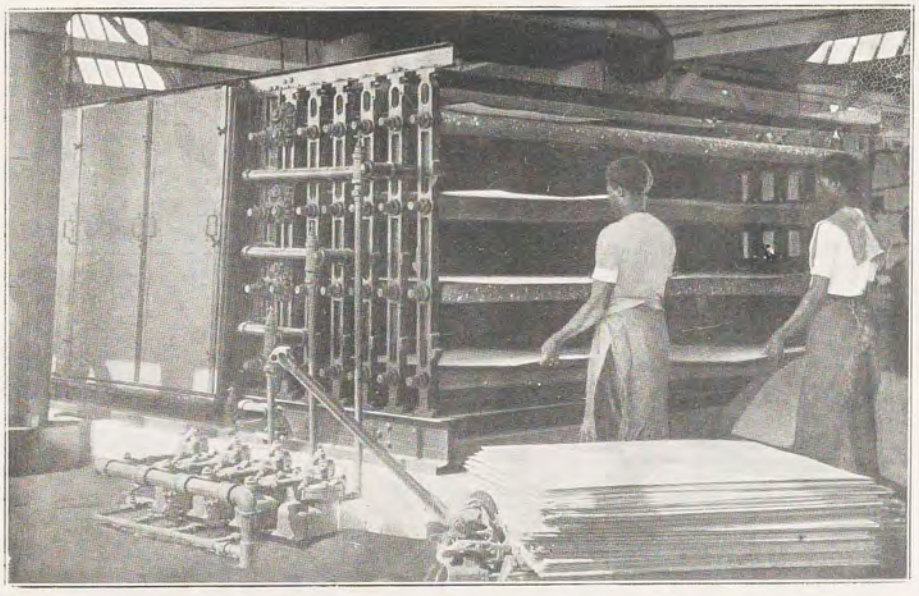
(*c*) Separation of the diamond from the heavy minerals by which it is accompanied in this final concentrate.

Natural pulverization or "flooring" was, until recent years, employed on an enormous scale, particularly at Kimberley. In this process the "blue ground" coming from the mines is spread out in layers, averaging about 11 inches in thickness, on level depositing floors, and there left exposed for periods of from six to eighteen months to the influence of the atmospheric agencies, being harrowed and watered during periods of drought. Through this treatment ordinary "blue ground" is very thoroughly disintegrated, thereby rendering possible the concentration of the diamond by simple washing processes. As the Kimberley mines became deeper and deeper the "blue ground" became less and less amenable to treatment

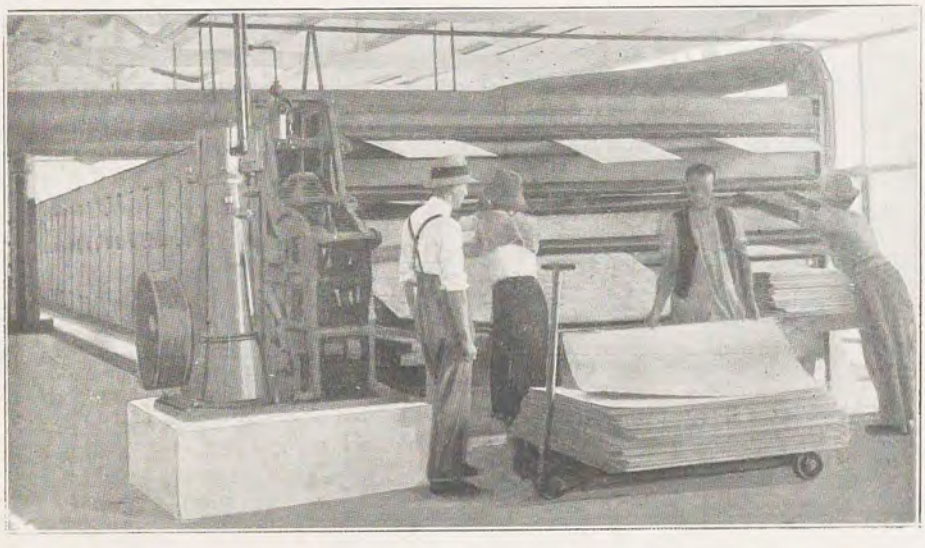


THE HUME PIPE.

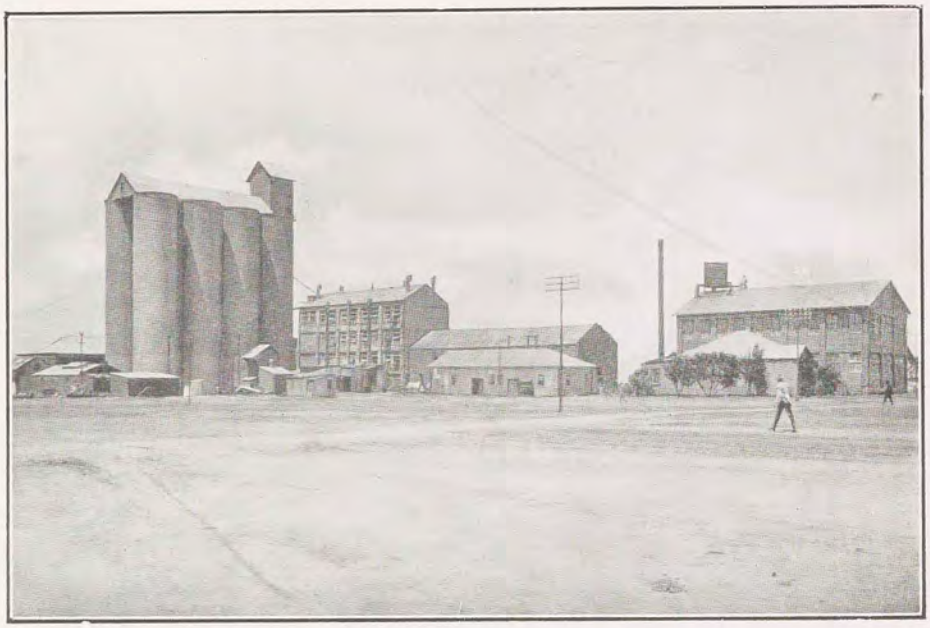
Above is the wire reinforcement, and below the finished pipe. At the end of the pipe can be seen the groove used in jointing.



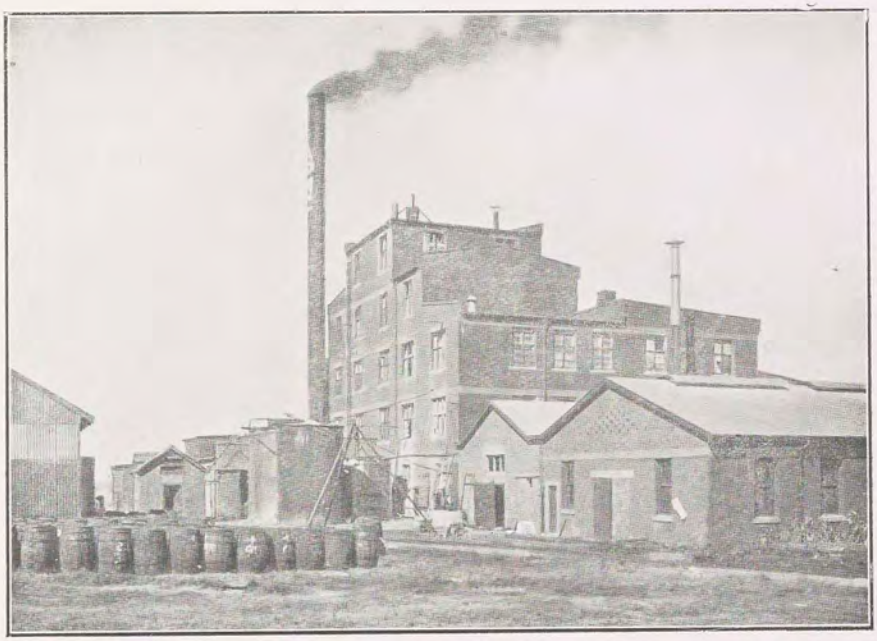
INSERTING WET VENEER INTO DRYER.



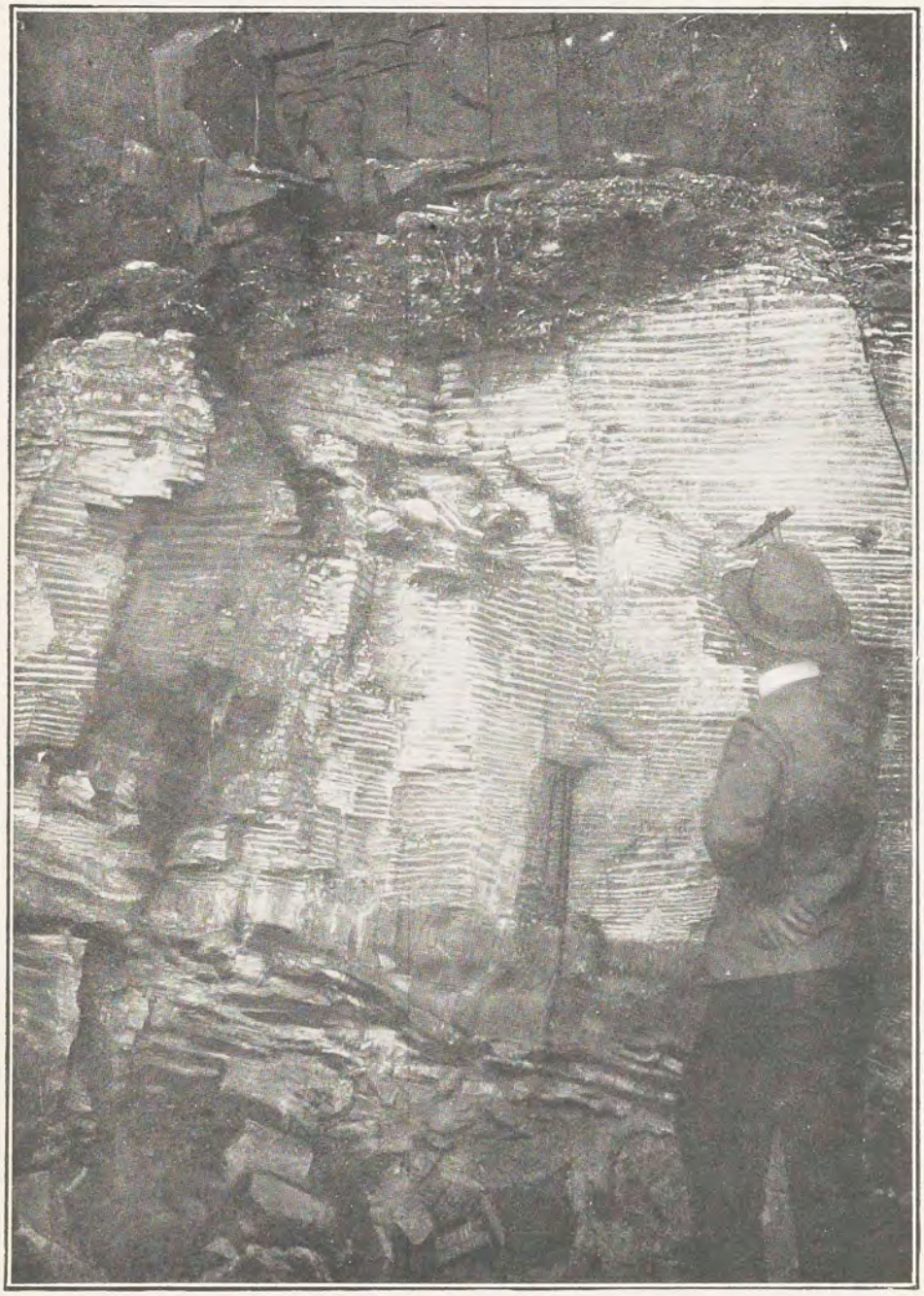
THE OTHER END OF THE DRYING MACHINE: REMOVING THE VENEERS.



GRAIN MILLS AND ELEVATOR AT VEREENIGING.



WHERE STARCH AND OTHER MAIZE PRODUCTS ARE MANUFACTURED.
The Works of the African Products Company, Germiston.



A FINE OUTCROP OF ASBESTOS, NEAR KAAPSCHE HOOP, TRANSVAAL.

by flooring, with the result that the period required for its complete disintegration became excessive, resulting in considerable loss of interest on the capital locked up in the deposited "blue ground." For this and other reasons it was resolved in 1920 to abandon flooring at Kimberley in favour of stage crushing and washing, or *direct treatment*, as it is popularly termed. At the Premier Mine direct treatment was adopted at the outset, and has given very satisfactory results. It is doubtful whether the actual recovery by direct treatment is ever as good as that by flooring followed by washing. The process, however, is cheaper and has other advantages, and it is not likely that flooring will ever again be carried out on a great scale, except at certain mines in the Orange Free State with established floors and washing plants.

The preliminary concentration of the crushed or naturally disintegrated "blue ground" is carried out in rotary washing pans or jigs.

The concentrate made undergoes further concentration in jigs or in tube mills, and from this secondary concentrate the diamond is, after further jigging, recovered on shaking grease tables or greased vanners; the separation being based on the well-known affinity of the diamond for grease (petroleum jelly). By these means the valueless matrix representing from 99·999988 to 99·999998 per cent. of the rock mined is progressively eliminated. The diamonds recovered are cleaned with petrol and hydrofluoric acid, and then classified according to size, crystallization, purity, and colour; as many as 1,000 grades being discriminated at the larger mines.

(During 1925 the mines of the Union of South Africa treated 11,658,227 loads of "blue ground," and tailings for a recovery of 2,190,871 carats of diamonds, valued at £6,291,510.)

Characteristics of the Diamond.—Each pipe and alluvial field produces diamonds having distinctive characteristics. After a little practice it becomes comparatively easy to pick out by their peculiarities of crystallization, colour, lustre, surface-markings, and the presence or absence of inclusions, parcels of diamonds from the different sources of production; some of the leading experts displaying marvellous proficiency in this respect.

The South African fields produce diamonds of every conceivable hue, but true blue-white or super-white stones are comparatively rare. As to crystal form, stones of octahedral and dodecahedral habit everywhere predominate, cubes being very rare except on the Kasai diamond fields, where over 1 per cent. of the diamonds are of cubical habit. As regards hardness, the Voorspoed and Premier pipes are credited with producing the hardest diamonds, while the South-West African stones are undoubtedly the softest and most easily cut. The quality and value of the diamonds vary greatly. It is difficult in this respect to find a satisfactory basis of comparison, as the average size of the diamonds produced on the different fields varies within very wide limits, and the value naturally depends on size. Thus, while the Kasai diamonds are of excellent water and many fair-sized stones are produced, the average weight for the Belgian Congo fields is only 0·08 carat, with the result that the average value is comparatively low. This is shown by the following table, giving the average value per carat during 1925 of the diamonds from the four principal sources of production:—

	s.	d.
Alluvial fields, Union of South Africa....	159	5
"Kimberlite" pipes, Union of South Africa	57	4
South-West African fields.....	54	4
Kasai fields (Belgian Congo).....	39	4

The "kimberlite" pipes produce the largest and most valuable diamonds, the comparatively low average value of their product being due to the fact that they yield a large proportion of stones of very inferior quality. This

is particularly the case with the Premier pipe, the greatest known repository of precious stones. It produces an unrivalled variety of diamonds, ranging from exquisite blue-whites and fancy stones on the one hand to unsightly bort and rubbish on the other. Almost 70 per cent. of the total output belongs to the last category, as is shown by the following table (column I), giving the percentage composition of the Premier finds during 1913. In column II there is given for comparison a similar analysis of a 20,000-carat parcel of South-West African diamonds.*

	I.	II.
Close goods †.....	1·68 ‡	23·95
Irregular stones.....	0·20	6·39
Brown stones.....	6·00 §	12·96 ‖
Slightly spotted and spotted stones.....	3·50	19·62
Blocks and cleavage.....	10·28	27·70
Twin crystals and flats..	9·44	8·57
Rubbish and bort.....	68·90 ¶	0·81
TOTAL.....	100·00	100·00

Control of Output and Sales.

Under agreements approved by the Government of the Union of South Africa the diamond output of the three big Union producers, namely, De Beers, the Premier, and the Jagersfontein Mines, and also the output of the South-West African Fields is purchased by the New London Diamond Syndicate with headquarters at Kimberley, South Africa. The quantities to be supplied are based on actual sales during the six months preceding the date of the determination and are adjusted six monthly. The price paid for the diamonds is also fixed six monthly on selling results. Under an inter-producers' agreement each of the main producers is allotted a definite quota of the total sales, production being kept as nearly as possible within the limits of these quotas.

A new inter-producers' agreement has been arrived at between the producers for five years, commencing 1st January, 1926, under which:—

	Per Cent.
De Beers Consolidated Mines, Ltd.: supply	51
Premier Diamond Mining Co., Ltd.: supply	18
Jagersfontein Diamond Mining Co., Ltd.: supply.....	10
The Consolidated Diamond Mines of South-West Africa, Ltd.: supply.....	21
Total.....	100

The sales of outside producers in South-West Africa are limited to a sum equal to 3 per cent. of the total sold by the big producers.

This total given above is exclusive of the production of the alluvial fields of the Union which is not controlled, and of the Koffiefontein, West End, and some other small mining propositions in the Orange Free State.

Friendly relations also exist between the Diamond Syndicates and the principal companies operating in the Belgian Congo and Angola—so that these companies co-operate with the Diamond Syndicate in maintaining the price of diamonds.

Diamonds for Industrial Purposes.

The diamond, by virtue of its incomparable hardness, is being put to an ever-increasing number of industrial uses, and there can be no question that in this direction there is a great future before it. A considerable proportion of the inferior stones produced by the

* For the figures in column II the writer is indebted to Mr. Arend Brink, diamond valuator to the Government of the Union of South Africa.
† The trade-name for well-formed crystals of good quality.
‡ Includes blue-white cleavage and fancy goods.
§ Includes brown "spotteds."
‖ Includes "frosted" stones.
¶ Largely made up of cleavage fragments.

South African mines have proved well adapted to the various uses to which industrial diamonds are put, the better classes of bort being successfully employed in diamond-drilling.*

The best industrial stones are found in the Jagersfontein and Wesselton Mines, but Premier stones also have a good reputation, and Premier cleavage is largely used for wire-drawing.

At present the market for industrial diamonds is greatly depressed owing to a very considerable production of stones of inferior quality even for industrial purposes on the Beceka (B.C.K.) fields of the Belgian Congo. The present output is 500,000 carats per annum, and this would probably be increased to 1,000,000 carats if it were not for the friendly relations existing between the Diamond Syndicate and the Belgian Congo producers. An agreement has been reached recently between a prominent firm specializing in industrial diamonds and the Syndicate in regard to the output of industrial diamonds. It is hoped that this will have a steadying effect on prices.

The Alluvial Diamond Fields of the Union of South Africa.

Alluvial diamonds have an extraordinarily wide distribution in the basins of the Orange, Vaal, and Harts Rivers, the most important deposits occurring in the beds and valleys of these streams and of certain of their tributaries, such as the Riet River south of Kimberley, and the Mooi River and Bamboes Spruit in the south-western Transvaal. New discoveries are continually adding to the already enormous area of the known fields, the latest being in the Lichtenburg and Potchefstroom Districts of the Transvaal, and the Taungs District of Griqualand West.

Patches of diamond-bearing gravel also occur along the Molopo River at Pitsani and other localities, and in the valley of the Limpopo and its tributary the Marico, while the valleys of some of the tributaries of the Pienaars River draining the Premier Mine area have long been the scene of diamond digging on a very considerable scale.

Finally reference may be made to the interesting deposits on the Kaap Plateau at Mahura Muthla.

The most productive alluvial deposits ever discovered are those in the northern part of the Lichtenburg District of the Transvaal on Elandsputte and Treasure Trove (portions of Uitgevonden No. 99), Grasfontein No. 240, Ruigtelaagte No. 205, and adjoining farms. They take the form of "runs" of gravel up to 60 feet in depth, deposited by an ancient river that traversed this part of the Transvaal in a north-east to south-west direction, the direction of flow having been to the south-west or south-south-west.

The diamonds of the alluvial fields are, as already indicated, on the whole superior in quality to those of the mines. The diamonds of the individual alluvial fields also vary greatly in quality. The best stones are produced on the Hopetown fields in the northern part of the Cape Province, and the poorest in the Lichtenburg and Pretoria districts of the Transvaal. This will be seen from the following table giving the value per carat of the diamonds produced on the principal alluvial fields of the Union during 1926.

Fields.	Value per Carat. s.	d.
Hopetown	238	2
Prieska	235	3
Kimberley	218	9
South-western Transvaal	98	7
Lichtenburg	65	0
Pretoria District	41	4

Origin of the Diamonds.—The widespread distribution of alluvial diamonds in the portion of central South Africa with which we have been

* True carbonado, the most satisfactory form of diamond for drilling purposes, is not found on any of the South African fields.

dealing is a natural corollary to the indestructibility of the diamond and the great denudation which the Kimberlite pipes have undergone. There can be no question, however, that sources other than Kimberlite have contributed to the formation of the alluvial deposits. Thus it is known that some of the green diamonds found on the Klerksdorp alluvial fields have been derived from the weathering of the conglomerates of the Witwatersrand system of that area which are known to contain diamonds of the same nature. These ancient conglomerates must have derived their diamonds from still more ancient primary sources, probably to be sought among the ultrabasic rocks of the Swaziland system. The diamonds are also stated to have been found in the amygdaloidal andesites of the Ventersdorp system, but there is some doubt as to the authenticity of the finds.

The Diamond Diggings.—The alluvial diamond fields afforded during 1926 a means of livelihood, in most cases very precarious, to no fewer than 11,842 white and 39,740 coloured diggers as an average throughout the year, the latter being for the most part employees of the former. Including white and coloured dependents, the total number of persons ekeing out an existence on the fields is probably in the neighbourhood of 100,000. Taking the diggers alone, the total value of the output of the fields during the period under review, namely, £3,983,681, had to be divided between 11,842 white and 39,740 coloured persons. Assuming that all of the coloured persons were employees, which is not very far off the mark, and allowing £2. 10s. per month in food and wages for these coloured labourers, this leaves £2,791,481 to be divided among 11,842 white diggers, giving an average income of roughly £235 per digger per annum. Out of this they had to support their families, pay for water, transport, tools, and licences. It is not surprising, therefore, that the utmost poverty prevails on the diggings, particularly when it is borne in mind that many of the diggers registered no finds whatever. Nevertheless the occupation, which is a very healthy one, has an irresistible fascination for many people, and it may safely be predicted that as long as any diamond-bearing gravel remains to be worked in South Africa, it will attract diggers from all ranks of the community.

All diamonds are now subject to export duty, but apart from this the only financial obligation imposed on the digger by the Government is payment of his claim licence. In the Transvaal, alluvial claims measure 45 feet square and are subject to a monthly tax of five shillings. In the Cape Province the standard claim is 30 feet square, but this has been increased by proclamation to 30 feet by 60 feet as regards Griqualand West. Claims of this size are also subject to a licence costing five shillings monthly. In the Orange Free State £1 per month is charged on the full claim of 90 feet square.

Diamond Cutting.—Several small cutting establishments have been in existence in Johannesburg, Kimberley and Pretoria for some years; the output has hitherto been negligible. Since 1917 there has been an export duty of 5 per cent. on rough diamonds. This had no perceptible effect in encouraging the local cutting of diamonds, and was in 1919 raised to 10 per cent. At the same time an Act was passed making it compulsory for producers of rough diamonds to sell to local cutters stones of the quality they require for cutting. This was done because local cutters had previously experienced difficulty in obtaining such a supply. It was felt that if cutting was being hindered for this reason the obstacle should be removed by making the sale to South African cutters compulsory, and this is the main provision in the Act. The local cutter will thus secure the advantage of the 10 per cent. export

duty plus the cost of selling rough stones in Europe, or altogether 12½ per cent. of the value of the rough diamonds. The cost of living has increased to such an extent in Holland and Belgium that the former advantages of these countries of lower wages than would have to be paid in South Africa has practically disappeared.

B.—COAL.

(See *Union Year Book*, page 606; Government Mining Engineer's Report, Memoir No. 3, Geological Survey of South Africa, "The Geology of the Transvaal Coal Measures," by E. T. Mellor; Memoir No. 19, "The Coal Resources of the Union of South Africa," by W. J. Wybergh.)

The coal measures of South Africa lie in what is geologically described as the Middle Ecca sandstones of the Karroo System. Mr. W. J. Wybergh has done much work in recent years, in examining the coalfields, and estimating the coal resources of the Union. The area covered by the coal measures is so large, however, that much remains to be done by drilling, and otherwise testing the coalfields, before the actual coal resources of the country can be definitely estimated. It must be sufficient to state that the Union's coal resources are enormous, and there is every reason for thinking that new coalfields will be discovered as the country is developed.

The exploitation of coal in South Africa is of comparatively recent growth, not extending further back than one generation, and even at the present moment the annual output of coal is about 12,000,000 tons in a normal year, an amount which is quite insignificant compared to the total resources of the country. Coal is, therefore, comparatively speaking, a drug in the market, and the competition is so keen amongst various producers that the pit's-mouth price in the Transvaal of about 5s. per ton is as low as anywhere in the world.

Such as our present knowledge is, it is contained in the following summary:—

Cape of Good Hope.—The workable occurrences are confined to the Molteno beds of the Stormberg Series, and are found at three well-defined horizons, known as the Indwe, Guba, and Molteno seams. Practically the whole output, however, has been obtained hitherto from the first and third of these. Generally, the coal occurs in comparatively small layers, much interlaminated with shale, with the consequence that a great deal of sorting has been necessary and working expenses have been high. It has at the same time a high ash and low volatile content, resulting in a low calorific value, placing it out of competition, except for purely local purposes, with the higher-grade coals that are now available. Such as they are, these coals have played a useful part in the development of the country and have been used in the past to great advantage, especially by the De Beers Company and the railways. Gradually, however, they have been forced out of the market, and there are now only two or three small companies continuing operations.

Natal.—The collieries are situated in the areas of Klip River, Dundee, and Newcastle; Utrecht, Paulpietersburg, and Vryheid, about 55 per cent. of the output coming from the last-named area. Altogether there are twenty-nine producing collieries in Natal, and the number is steadily being added to.

The area of the coalfield from which coal is now being raised is roughly 2,000 square miles, although probably only 50 per cent. of this area is coal-bearing. Until much additional boring has been done it is impossible to estimate with any attempt at accuracy the area and coal contents of this field. Taking Hattingspruit as the centre of this coalfield, the distance by rail to Durban, to which the bulk of the output goes, is 240 miles.

A colliery was started and worked at Somkele, in Zululand, some twenty miles from the coast, but the coal was too anthracitic and dirty to enable the colliery to continue working with success. Much coal exists in Zululand, but owing to the distance from railways, very little prospecting has taken place. The Zululand coalfield is therefore an unknown quantity, which may, however, become of the utmost importance as that country develops and additional railways are constructed therein.

The Natal coal is of excellent quality. The following are analyses of typical Natal coals turned out by the pits at present working: —

ANALYSES OF NATAL COALS.*

Name of Colliery.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Calorific Value as per Mahler Bomb Process.	Sulphur.
Dundee Coal Company (Burnside)	0·56	23·74	68·40	7·30	15·05	1·48
Natal Navigation	0·90	21·78	69·91	7·41	14 to 15·15	1·30
Durban Navigation	1·40	30·40	58·50	9·70	13·80	0·94
Northern Navigation	2·00	25·30	64·50	8·20	14 to 14·50	0·83
Hlobane	1·50	19·30	68·30	10·90	13·84	0·96
Enyati	1·70	22·20	67·80	8·30	14·40	0·84
Tendega	1·20	21·70	69·10	8·00	14·23	0·75
Wallsend	1·25	20·75	66·60	11·40	13·84	—

* Report of Coal Commission, 1921.

One colliery (Dewar's Anthracite) supplies nothing but anthracite, which is found very suitable for suction gas-engines, etc.

Transvaal.—Coal in the Transvaal is known in four geographical districts: —

(*a*) The High Veld.—This is in the section made by the Natal-Johannesburg railway in the west, by the Delagoa Bay-Johannesburg railway in the north, and a line drawn south from the Belfast to the Natal boundary at Paulpietiersburg on the east. This is the only area on which coal is at present mined, with the exception of the small area at Vereeniging on the north side of the Orange Free State boundary where the measures detached from the main high veld area nevertheless belong to it. This area is probably not less than 450 square miles in extent.

(*b*) The Bushveld Area.—This is an area beginning some thirty miles north of Pretoria. Coal measures, which have in various places been proved to overlie coal, occur over an oval-shaped area some seventy by twenty miles in diameter. Coal seams of considerable thickness have been struck in boreholes and in one shaft. The coal where struck appears of an inferior quality, but would be a useful fuel if a calorific value of ten were accepted. This area is about 750 square miles in extent.

(*c*) The Lebombo Area.—This contains a strip of coal measures which outcrops over a width of some six miles along the whole eastern boundary of the Transvaal and Swaziland, some twenty miles west of, and parallel to, the Portuguese border. This coal has not yet been worked, but where opened it appears of good average South

African quality, but anthracitic in character, and much disturbed by the neighbouring igneous mass of the Lebombo Hills.

(*d*) The Limpopo Area. — Coal measures occur over a very considerable area in the northern Transvaal, stretching from the Lebombo westwards along the Limpopo Valley. The coal in these measures is only opened in one place, Lilliput, where the Messina Copper Company worked a small pit for fuel for their smelter. The seam worked is 3 feet wide and is rather inferior, the selected coal having probably a calorific value of not more than 10.5. Neither the Lebombo nor the Limpopo areas are sufficiently well known to attempt an estimate of their size, but 2,000 square miles would probably be a conservative estimate.

(*e*) The North Waterberg Area (see "Coal in the Northern Waterberg," *South African Journal of Industries*, April, 1922).—This is an extension of the Limpopo area. In the country lying between the Matlabas River on the west and the Palala on the east, coal has recently been struck in boreholes which were being sunk in connexion with a search for water. A core drill in 1921 proved these measures on the farm Grootgeluk No. 1360. From the surface down to 140 feet eight coal seams were encountered. Of these, the following were of workable dimensions:—

Seam.	Depth.	Thickness.
B.	45 feet.	5 feet 6 in.
C.	57 feet.	7 feet 0 in.
D.	75 feet.	10 feet 1 in.
F.	134 feet.	6 feet 8 in.

From 134 feet to 302 feet no definite coal seam was encountered, but at that depth seam "G" of 22 feet was proved, and at 336 feet seam "H" of 13 feet. The borehole was continued to 500 feet, but no further coal was found.

The analyses of these coals, which are in the possession of the Mines Department, show that the lower seams are of the ordinary South African quality and quite up to the usual standard. The upper seams, however, are extremely bituminous and of a very much better coking quality than any yet encountered in the country.

The area underlain by coal in the Transvaal appears to be about sixty miles from east to west and thirty miles from north to south, but stretches an unknown distance into Bechuanaland in the neighbourhood of Palla Road Station on the Rhodesian railway.

The following analyses may be taken as representative of Transvaal coals as at present mined:—

ANALYSES OF TRANSVAAL COALS.*

Name of Colliery.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Calorific Value as per Mahler Bomb Process.	Sulphur.
Apex	5·28	17·27	50·09	27·36	9·03	1·14
Bellevue	3·75	31·47	52·46	12·32	12·34	1·50
Breyten	2·75	30·42	50·87	15·96	12·03	1·00
Largo	4·50	24·50	52·00	17·50	10·50	1·50
Middelburg Steam	0·94	24·46	60·63	12·62	13·06	1·35
Oogies	3·20	26·96	56·34	13·50	12·57	1·54
Transvaal and Delagoa Bay.	1·38	22·38	59·40	15·58	12·56	1·26
Witbank	0·94	27·04	56·96	13·82	13·01	1·24

* Report of Coal Commission, 1921.

Orange Free State.—The chief producers are the Cornelia Colliery, on the Vaal River opposite Vereeniging, and the Clydesdale, about fifteen miles to the south, but there is also one small pit working at Vierfontein, about eighty miles to the south-west, on the Klerksdorp-Kroonstad railway line. The Orange Free State field is of great extent, having an area of probably 10,000 square miles. The coal seams vary in number from one to four, and their aggregate thickness from 6 feet to 53 feet. The seams are quite persistent and continuous and maintain an even value. Unfortunately, the grade of all seams is uniformly low, and ranges from a calorific value of 8.0 or less to a maximum of 11.25. At the same time, the seams furnish a useful steam coal, which for household purposes is generally preferred to any other.

Coke, By-products, Tar, etc.—(i) *Coke.*—Coke is manufactured in Natal and the Transvaal, but the one concern at present working in the latter Province has so far only produced one small parcel.

In 1926 the amount of coke sold was 87,099 tons, valued at £106,153.

Natal coke is of excellent quality, especially for foundry work, being very dense and hard. Analyses of a typical Natal coke taken over a period of two years gave the following results: Fixed carbon, from 88.60 per cent. to 89.40 per cent.; ash, from 10.4 per cent. to 9.80 per cent.; sulphur, from 0.60 per cent. to 0.50 per cent.; calorific value, 13.12.

(ii) *By-products.*—The Dundee Coal Company is producing the following by-products at its Waschbank Factory, Natal; Tar, sulphate of ammonia, light creosote oil, naptha salts, and solvent naphtha.

The South African Carbide and By-products Company, Ltd., is producing calcium carbide at the Ballengeich Colliery, Natal.

(iii) *Tar.*—During 1926 one mine in the Transvaal sold 133,593 gallons, valued at £6,839, and the Dundee Coal Company in Natal sold 252,031 gallons for £8,619.

Employment and Accidents in Coal Mining.—The number of persons employed in coal mining in each of the Provinces during the year 1926 is shown below (the table also shows the number of persons killed and injured, with proportion killed per thousand employed):—

EMPLOYEES AND ACCIDENTS—COAL MINES, 1926.

Province.	Persons Employed in Coal Mining.		Accidents.		Death Rate from Accidents per 1,000 Employed.
	White.	Coloured.	Persons Killed.	Persons Injured.	
Cape of Good Hope	9	93	—	—	—
Natal	763	19,123	178	394	8·95
Transvaal	840	15,104	37	178	2·32
Orange Free State	124	2,256	3	29	1·26
UNION	1,736	36,576	218	601	5·69

Labour in Union Collieries.—In the collieries the white miner is in the position of a supervisor, having usually from fifty to one hundred natives employed under him. He does little manual work, beyond conducting blasting operations and examining the places before the natives enter and start work.

Natives (the aboriginal inhabitants of South Africa) do all the harder work, such as hewing the coal, filling, and tramming. In Natal, Indians are largely employed, and are efficient in supervising stationary engines, running coal-cutters, erecting timber underground, pipe and track laying, etc.

Wages (Coal Mines).—White miners' wages vary from 24s. to 30s. a day. The hours af labour were reduced progressively to fifty-four and then to fifty-one per week as from 1st July, 1920. In the Witbank district the hours were reduced to forty-eight per week. Natives draw from 40s. to 60s. a month, with free quarters, rations, and medical attendance. Indians' wages are the same as natives, but the Indian, as a rule, remains longer at the collieries and gets more proficient. He therefore, in some cases, receives a higher remuneration.

The following statement shows the wages earned on the collieries in 1926:—

WAGES PAID IN COLLIERIES OF UNION, 1926.

Province.	European.	Asiatic.		Native and Other.	
		Males.	Females.	Males.	Females.
	£	£	£	£	£
Cape of Good Hope	852	—	—	1,952	77
Natal	311,311	54,334	—	472,365	76
Transvaal	348,816	285	—	440,516	132
Orange Free State	46,717	—	—	65,138	—
UNION	707,696	54,619	—	979,971	285

Importance of Coal to the Union.—Being such a long distance from any of the important coalfields of the world, the South African coal deposits are of the utmost value, not only to the Union but to Africa generally, and to the large numbers of ships which now call and coal at Union ports. South Africa is anything but a well-wooded country, and if no coal had been available in the Union itself, it is improbable that the gold and diamond mines, which have so largely contributed to the development of the country, could have been successfully carried on. New industries are being started in the Union, all of which will benefit largely by cheap fuel, and as water power is not available in quantity, the country would be unlikely to secure industrial prosperity were it not that it has an ample supply of the cheapest coal in the world.

The chief present consumers of coal are the mines, the Government railways, and the ships which coal at Union ports.

There is every reason to anticipate a bright future for the coal industry. The Union is only in an early stage of

development. With the increase of railway communication and the opening up of the numerous industries for which South Africa has the means and facilities, a large demand for coal must follow. As the Union develops, the amount of shipping coming to the country will increase, and such shipping will coal at Union ports. The export of coal from the Union has increased and such countries as Kenya, the Soudan, Mauritius, Madagascar, India and Ceylon are likely to require steadily in increasing quantities of Union coal.

It is as yet too early to estimate the ultimate dimensions of the coal by-product industry. It is unlikely that such countries as the South American Republics, Madagascar, and Mauritius will go to Europe and the United States of America for coal by-products if they can obtain them at less cost in South Africa.

For many years to come South Africa should be able to supply coal at a cheap rate; while wages are likely to increase in older countries the native of South Africa will probably remain content to work for far less than a European. This fact, taken together with the favourable geographical situation of the Union, enables the country to compete on advantageous terms with the other coal-producing countries of the world.

Transvaal coals are graded "Witbank District" and "Ermelo District." The minimum calorific value in case of "Witbank District First Grade" is fixed at 12.75, in case of "Ermelo District First Grade" at 12.00.

Only 1st Grade coals not liable to spontaneous combustion are exported.

Price of Coal.—The price of coal varies very much in the different Provinces. The reason for this difference in prices is largely due to the situation of the collieries. Thus, the Cape Province coal, which is the most inferior in the Union, fetches the highest price, because coal from the other Provinces has to be transported by rail to the Cape Province, thus enabling the local coal to maintain its high price.

Natal coal is the best in the Union, and the up-to-date port of Durban being now a large coaling station, the considerable bunker and export trade done at this port, and the high quality of the coal supplied, enable the Natal collieries to command comparatively high prices for their output.

There has been no great fluctuation in prices in recent years, except in Natal. The Transvaal and Orange Free State coal is mostly consumed in those Provinces, and as the demand is no greater than the supply, there has been little opportunity for prices to increase. In Natal it is different. Much coal is consumed by passing ships willing to pay good prices for it, and this, coupled with the rise in the price of coal in the United Kingdom, has tended to raise the price of coal in Natal. From the following table it will be seen that while the price at the pit's mouth has remained almost stationary in the Transvaal, Cape, and Orange Free State Provinces, there has been a steady rise in the price of Natal coal until 1921, since which time there has been a marked fall in the price.

AVERAGE PRICES OF COAL (PIT'S MOUTH), UNION, 1911 TO 1925.

Period.	Cape of Good Hope.	Natal.	Transvaal.	Orange Free State.
	Per ton.*	Per ton.*	Per ton.*	Per ton.*
1911	11s. 6·98d.	5s. 4·98d.	4s. 8·39d.	5s. 8·42d.
1912	11s. 0·55d.	5s. 6·99d.	4s. 4·78d.	5s. 4·57d.
1913	11s. 5·82d.	6s. 1·83d.	4s. 4·48d.	5s. 5·87d.
1914	11s. 7·50d.	6s. 10·80d.	4s. 5·55d.	5s. 5·58d.
1915	11s. 4·22d.	6s. 9·50d.	4s. 4·82d.	5s. 2·14d.
1916	11s. 6·49d.	7s. 4·77d.	4s. 6·07d.	5s. 2·54d.
1917	14s. 4·05d.	10s. 1·76d.	4s. 9·32d.	5s. 1·86d.
1918	15s. 3·89d.	10s. 5·10d.	5s. 0·84d.	5s. 6·70d.
1919	15s. 9·12d.	10s. 7·41d.	5s. 1·40d.	5s. 6·25d.
1920	15s. 5·22d.	12s. 3·40d.	6s. 1·12d.	5s. 11·43d.
1921	15s. 7·91d.	14s. 1·71d.	6s. 7·32d.	6s. 0·82d.
1922	15s. 2·86d.	9s. 2·80d.	5s. 7·34d.	5s. 9·12d.
1923	14s. 5·76d.	7s. 10·70d.	5s. 3·04d.	5s. 6·61d.
1924	14s. 2·37d.	7s. 8·89d.	5s. 0·90d.	5s. 6·79d.
1925	14s. 4·98d.	7s. 5·13d.	5s. 0·67d.	5s. 6·88d.
1926	13s. 11·69d.	7s. 2·99d.	5s. 0·00d.	5s. 7·46d.

* 2,000 lb.

International Comparison of Prices.—Apart from the price of Cape coal, which is relatively high on account of the scarcity of coal in that Province, the price of coal in the Union compares very favourably with the prices in other parts of the world.

The average pit's-mouth price in the United Kingdom in 1925 was approximately 19s. 4d.

Coal Commission and Coal Act.—The Coal Commission was appointed in 1920 to report upon the measures required for—

(*a*) the effective grading and pooling of South African coal intended for export and for bunkering;
(*b*) the equitable distribution of the cost amongst the participating collieries; and
(*c*) the discouragement of the export of low-grade coal.

The Commission was also required to report upon the necessity of safeguarding the supply of coal for local consumption, and for the use of railways and harbours and other public services.

The report was issued in May, 1921, and was summarized in *Official Year Book* No. 4.

The Coal Act, No. 27 of 1922, which came into effect on the 1st September, 1922, followed the lines of the Coal Commission's report. Its main provisions may be thus summarized:—

(i) No coal produced within the Union is to be used for export or bunkering unless it has been graded and a certificate in the prescribed form has been granted in respect thereof.
(ii) A committee to control the grading of coal may be appointed, consisting of a chairman, nominated by the Minister, and four members, either all nominated by the collieries or two nominated by the collieries and two by the Minister. Members and officers of the grading committee may enter any colliery or place where there is coal at any time. Reasonable assistance in the work of grading and inspecting must be given by the officers and

servants of the colliery or place concerned with the bunkering and export of coal.

(iii) A monetary levy is to be made on the collieries by the grading committee at the commencement of its operations, this levy to be based upon the tonnage shipped by the several collieries during the preceding six months. Every quarter afterwards the amount levied is fixed in proportion to the amount of coal supplied during the preceding quarter by each of them for export and bunkering.

(iv) Export and bunkering of coal may be restricted or prohibited by the Minister if there is any real or apprehended scarcity.

Provision is also made for the requisition of coal by the South African Railways and Harbours Administration in times of scarcity of available coal, and for the issuing of regulations. Penalties for the contravention of the Act are laid down.

C.—OIL SHALE AND TORBANITE.

(See Industries Bulletin No. 100, "Oil-yielding rocks in the Union of South Africa," by T. G. Trevor.)

At the present time, when it is believed that the supplies of oil which can be drawn from the natural liquid oil wells of the world have reached their maximum, and the demand for oil is increasing by leaps and bounds, great attention is being paid to the occurrence of oil shale, torbanites, and coals of high volatile-content. In these the Union of South Africa appears to be particularly rich, though up to date none of them have been worked. Apart from the coals which are mined for steam-raising purposes, there are many seams known which give extremely high distillates, and which laboratory tests have shown to be very high in such by-products as nitrogen, etc. Apart from these there are torbanites indistinguishable from those of Boggshill, in Scotland, which yield distillates of up to 98 gallons to the ton. These torbanites or oil-yielding shales are very widely distributed in the Union of South Africa. Their discovery, so far, has been mostly accidental, but should prospecting for them become general, the area of their extent may be found to be very much greater than is at present suspected.

In three districts the deposits of "shale" are sufficiently developed to merit immediate attention, though in no case has investigation been carried far enough to justify the erection of plants. These districts are—

(*a*) Ermelo District (Mooifontein and neighbourhood).

(*b*) Wakkerstroom District (properties of African Oil Corporation and neighbourhood).

(*c*) Impendhle, Natal (Duart Castle, Waterfall, and neighbourhood).

To take these in order.

1. *Ermelo District.*—The shale here is extremely rich, yielding, by the writer's tests, from 22 to 98 gallons to the ton. It probably extends over areas which can be reckoned by the tens of square miles, but insufficient work has yet been done to estimate definite tonnages on any one mining area, or on the whole district, nor have sufficient tests been made to justify any estimate of average richness, though, so far as these go, it appears likely that an average of 40 gallons per ton may be obtained. The existing railway traverses the area, and working facilities are excellent. Unfortunately, the seam appears to average little over 1 foot in width, though greater widths have been encountered.

2. *Wakkerstroom District.*—The African Oil Corporation has proved on its property the existence of at least 7,000,000 tons of available shale, giving, over a mining width of 30 inches, a yield of 30 gallons to the ton. This, as it stands, is satisfactory from a mining point of view, but it will

become very much more so if further areas of shale are proved. That this will be done appears to the writer almost certain, for, to the south, under the mountain, and, to the east, towards Winterplaats No. 48, and Spruitfontein No. 238, much work remains to be done before the continuance of the beds is disproved.

The question is, however, complicated by the distance from the railway, which will necessitate, in order to join the line at Wakkerstroom, the construction of some eighteen miles of railway at a cast of about £5,000 per mile. If, however, the proposed port on the coast of Zululand is ever constructed, the position will be entirely altered, for the coalfields of this area will then justify a line from Piet Retief, independently of the shale, and the property will become excellently situated geographically.

3. *Impendhle (Natal).*—The so-called shale of this area is not as rich as that of the two already reviewed, nor does it seem likely, to the writer, to be as amenable to treatment in a retort, for under laboratory tests it intumesces and cakes badly, and the deposits are unproven over any mining area. Geographically, it is badly situated. The risks, therefore, attendant on its immediate exploitation are far greater than in the other areas; though, when once the industry is established elsewhere, it may be found that this field can be worked profitably.

The following table gives the results of laboratory distillation tests conducted by the Government on some of these shales and coals:—

Sample.	Width in Inches.	Oil Yield. Gallons per Ton.	Am. Liq. Gallons per Ton.	$AmSO_4$. Lb. per Ton.	Residue. Per Cent.	Ash in Residue, Per Cent.	Ash in Original.	Specific Gravity.	Gas Yield. Cubic Feet per Ton.	Sulphur. Per Cent. in Original.	Remarks.
Bethal District.											
Smit's Coal Mine, Driefontein No. 22.....	12	49	20	15·6	59·5	50·2	29·9	1·42	4,700	0·70	Specific gravity crude oil, 0·897.
Ermelo District.											
Torbanite Mine (Torbanite).....	12	98	6	3·4	40·2	56·3	22·6	1·25	3,300	0·71	Specific gravity crude oil, 0·862.
Steenkoolspruit No. 88 (Torbanite, No. 2 working)	4+	79	12	8·5	50	49·3	24·6	1·27	3,150	1·84	Specific gravity oil, 0·873; exposure incomplete.
Wakkerstroom District.											
Kromkoek No. 76 (Torbanite, No. 9 working)..	21	33	15	9·7	70	77·7	54·2	1·55	4,300	0·78	Specific gravity crude oil, 0·887.
Winterplaats No. 48 (Mixed shale from eight exposures)	45	34	8	9·9	65·8	71·6	47	1·6–1·93	3,260	0·59	—
Utrecht District.											
Kaffirs Drift *(Coals, K. Coal, Main Seam).....	24+	27	16	33·4	67·5	9·3	6·3	1·27	6,500	1·40	Exposure partly secured by water.
Impendhle District.											
Duart Castle (Coal).....	—	28·5	10·5	12	67·5	34·2	23·1	1·43	6,400	0·86	Specific gravity oil, 0·98; strongly coking in retort.
Heidelberg.											
Herbstfontein (Torbanite).....	—	36	19	10	65·1	75·8	47·7	1·57	2,500	0·77	Sample received after completion of retort.

	Moisture.	Ash.	Fixed Carbon.	Volatile.	Evaporative Power.
* K. Coal, Main Seam.....	1·89	6·04	58·38	33·69	14·53

The nature of the crude oil obtained from the shales of the deposits described can be judged from the following examples of fractionation tests which have been supplied to me:

Ermelo District: Mooifontein.

(Analyst, Dr. Norman, London.)

Crude oil..... 30·1 gallons per ton.

Classification of products:—

Petroleum spirit, by volume.	5 per cent.
Burning oils.....	36 ,,
Lubricating oils.....	38 ,,
Pitch.....	21 ,,
	100 ,,
Sulphur in crude oil.....	1·71 ,,

Wakkerstroom District: Kromhoek.

(Test by Pumpherston Works, Scotland.)

60 tons shale gave 31·75 gallons to the ton.

100 gallons fractionated gave:—

Naphtha.....	8·41 per cent.
Burning oil.....	16·40 ,,
Fuel oil.....	20·11 ,,
Lubricating oil.....	21·41 ,,
Wax.....	3·45 ,,
Residue coke.....	2·56 ,,
Tar and waste.....	27·59 ,,

Utrecht District: Kommissie Kraal.

(Analyst, A. Kloot, Durban.)

Oil, 29·9 gallons. Specific gravity, 0·88.

Temperature.	Distillate per cent.	
75°	4·0	Light oils.
100°	1·5	
150°	14·5	
250°	8·0	Burning oil.
300°	30·0	
Residue oils	42·0	Lubricating and fuel oils.

Impendhle District: Duart Castle.

(Analyst, D. F. M. Perkin, Sudbury.)

Proximate analysis:—

Volatiles.....	25·67 per cent.
Ash.....	41·85 ,,
Fixed carbon.....	32·48 ,,
Nitrogen.....	0·65 ,,
Sulphur.....	1·15 ,,

Yielded 21·12 gallons oil, specific gravity 0·9567.

Fraction up to 170° C.....	11·21 per cent.
from 170–230° C.....	12·82 ,,
230–360° C.....	43·26 ,,
Pitch.....	32·71 ,,

With regard to the crude oil obtainable from the distillation of the coals of high volatile-content, the following information is available:—

1. *No. 4 Seam, Dumbe Colliery.*

(Analyst, British Fuel Research Board, 1922.)

(Dry) Gallons per long ton, 16·1. Specific gravity, 1·052.

Distillation.	Per Cent.	Specific Gravity.
170° C.....	9·53	0·830
170–230° C.....	14·95	—
230–270° C.....	14·28	0·975
270–310° C.....	11·82	1·001
Pitch.....	46·52	—
Loss.....	2·90	—
	100·00	

2. *Coal Seam, 3 feet, Kommissie Kraal, Utrecht District.*

(Analyst, Alfred A. Kloot, Durban.)

Calorific value.... 14·86

Total oils..... 21·2 per cent., per short ton

Distillation:—

Water.....	1·00 per cent.
Oils up to 170°.	6·00 ,,
Oils up to 230°.	16·50 ,,
Oils up to 270°.	9·00 ,,
Oils up to 310°.	15·50 ,,
Pitch.....	52·00 ,,
	100·00 ,,

In the areas mentioned, the beds are all horizontal or approximately so, and can be worked by adit. The roofs are invariably good, and mining conditions may be regarded as identical. Mining costs under these conditions are well known, as the same obtain in the Natal collieries, and may be taken as 4s. per ton on a 4-foot seam, or 4s. 6d. on a 3-foot seam; three feet being the minimum mining width, the cost of a 1-foot seam would be nearly three times that amount.

D.—IRON.*

(See Wagner, P. A., and Stanley, G. H.—*South African Mining Journal*, Nos. 1348, 1349, 1351; Stanley, G. H.—*South African*

* By Percy A. Wagner, Geological Survey.

Journal of Industries, December, 1917; Wagner, P. A.—Memoir No. 17, Geological Survey, Union of South Africa).

The Union of South Africa possesses fairly large reserves of high-grade and vast reserves of medium-grade iron ores. She also has big reserves of all the other raw materials required for the production on a big scale of iron and steel, and is thus clearly destined to become an important producer of both these commodities.

The principal occurrences of iron ore may be classified as follows:—

1. Deposits formed by magmatic segregation.
2. Replacement deposits connected with igneous rocks.
3. Deposits of sedimentary origin.
4. Deposits of the Lake superior type.

1. Here belong the great stratiform segregations of titaniferous magnetite occurring in the upper part of the Norite Zone of the Bushveld Igneous Complex. They are up to 15 feet in thickness and can be traced for hundreds of miles. They thus contain vast reserves of ore, but owing to their high titania content, which ranges from 14 to 19 per cent., there is no prospect of their being utilized in the immediate future. It is important to note, however, that experiments carried out by Professor G. H. Stanley have shown that the titanium oxide can be readily fluxed by means of silica and lime, so that these ores could be advantageously smelted in admixture with the siliceous oolitic ironstone of the Pretoria series, to be presently referred to. An analysis of a typical specimen of the ore is given in Table I, at end of Chapter.

There is also an important deposit of titaniferous magnetite of magmatic origin in the Tugela Valley below Middel Drift in Natal. Analyses show from 9.2 to 19.7 per cent. of titanium oxide, and from 42 to 54 per cent. of iron.

2. The most important deposit under this heading is situated on the farm Kromdraai No. 459, 40 miles north-north-east of Pretoria. It is a stratiform replacement deposit in a series of conglomerates, grits, and tuffs intercalated with the felsites of the Rooiberg series. The dip of the iron deposit conforms to that of these rocks which is to the south-east at from 10 to 12 degrees. The ore consists mainly of small crystals of specularite. It is very free from phosphorus and sulphur, but on the other hand rather siliceous. Thus a representative sample over a thickness of 11 feet, in the main exposure of what is known as the "blue" ore, occurring at the centre of the deposit, contained 60.5 per cent. of iron, and 13.7 per cent. of silica. Another partial analysis of this type of ore is given in Table I. Apart from the "blue" ore, of which only a relatively small tonnage is present, there are available fairly big reserves of "purple" ore and big reserves of more siliceous "red" ore, interspersed with pebbles and fragments of felsite.

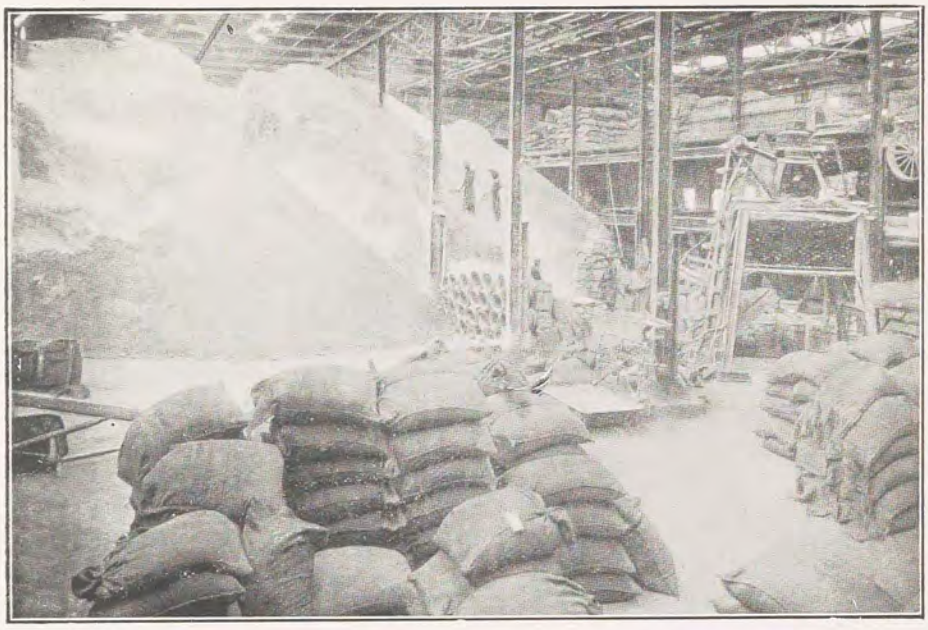
Lesser occurrences of specularite ore are widely distributed in the Rooiberg series, the source of the iron being the Red Granite of the Bushveld Complex.

To the same category as these deposits may be referred the occurrence on Beechwood No. 1405, situated 25 miles west-north-west of Nylstroom. It is of the nature of a replacement deposit following a line of fissure in felsite. The ore is hematite containing up to 4.1 per cent. of manganese.

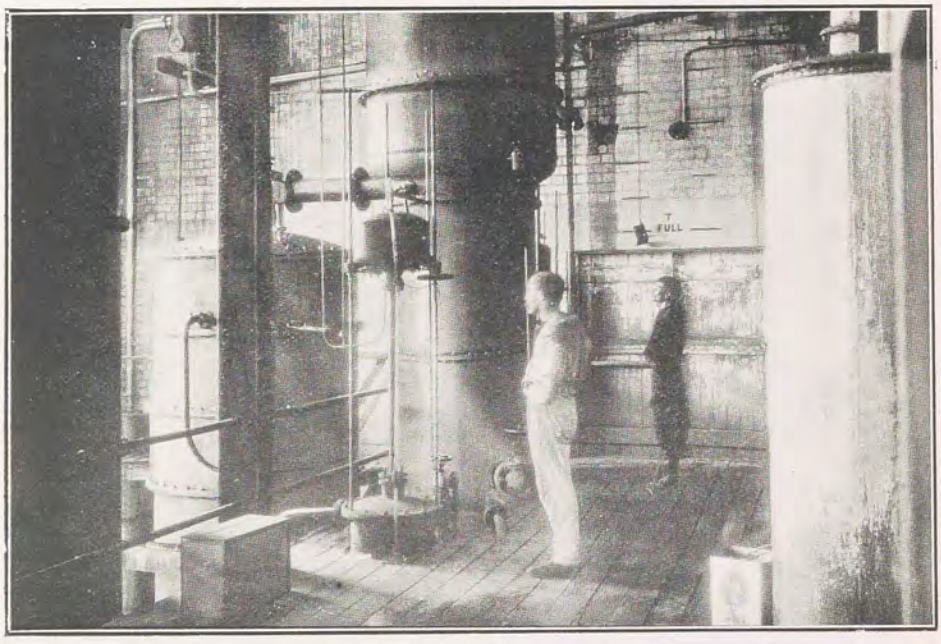
3. There are very important deposits of sedimentary iron ores in the Pretoria series of the Transvaal system and in the Ecca system of the Karroo system.

Iron Ores of the Pretoria Series.—These can be referred to three main horizons, namely:—

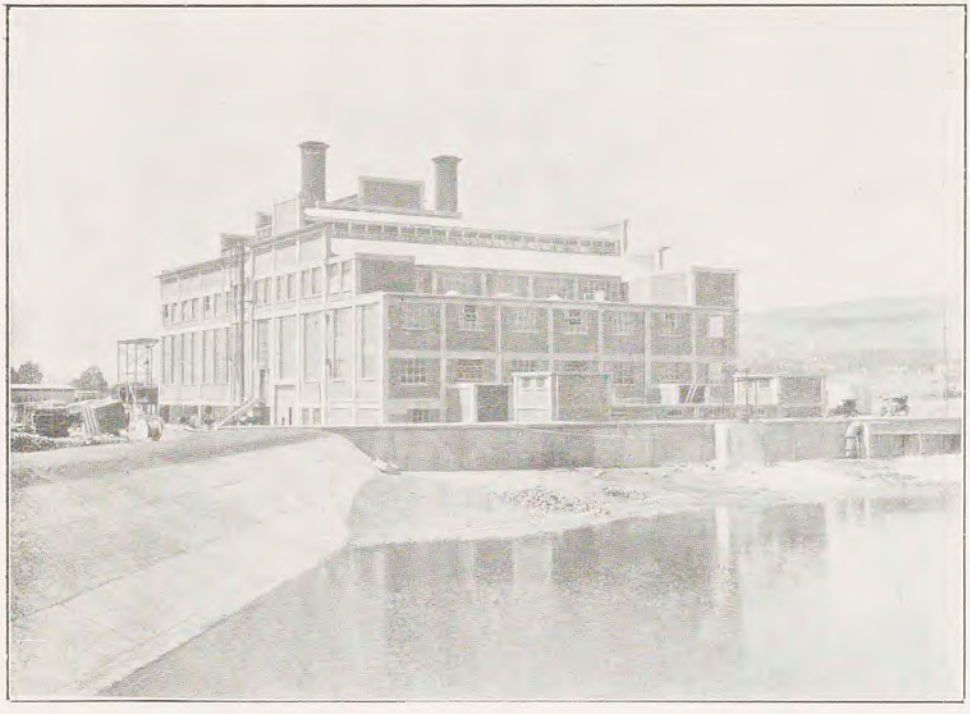
(*a*) The so-called Magnetic Quartzite.
(*b*) The Clay Band.
(*c*) The Daspoort Horizon.



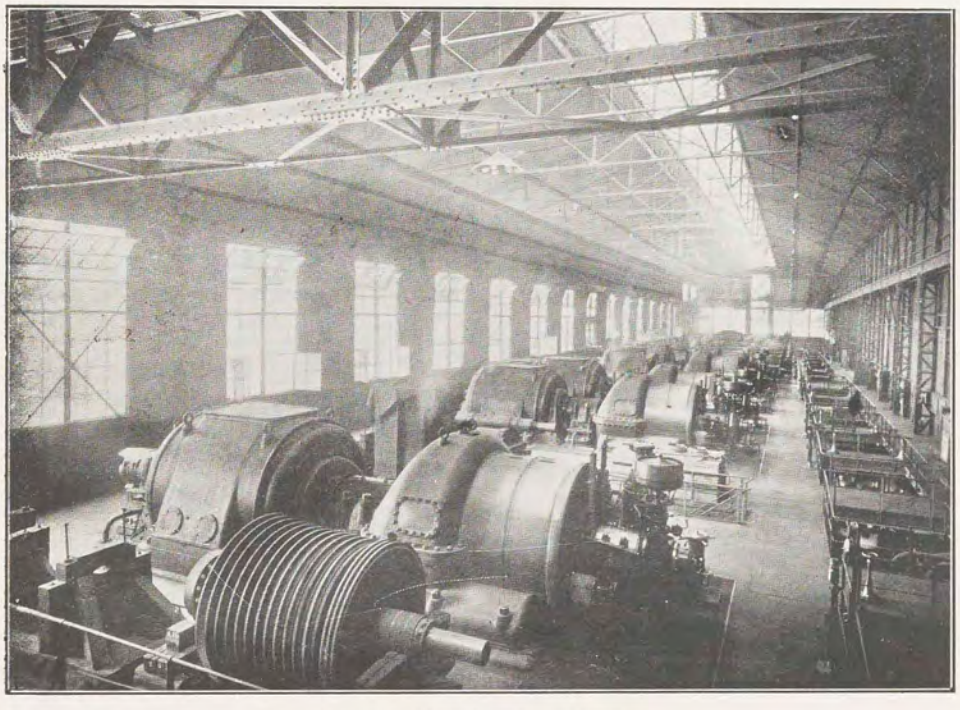
INSIDE A SUPERPHOSPHATE STORE AT KYNOCH'S.



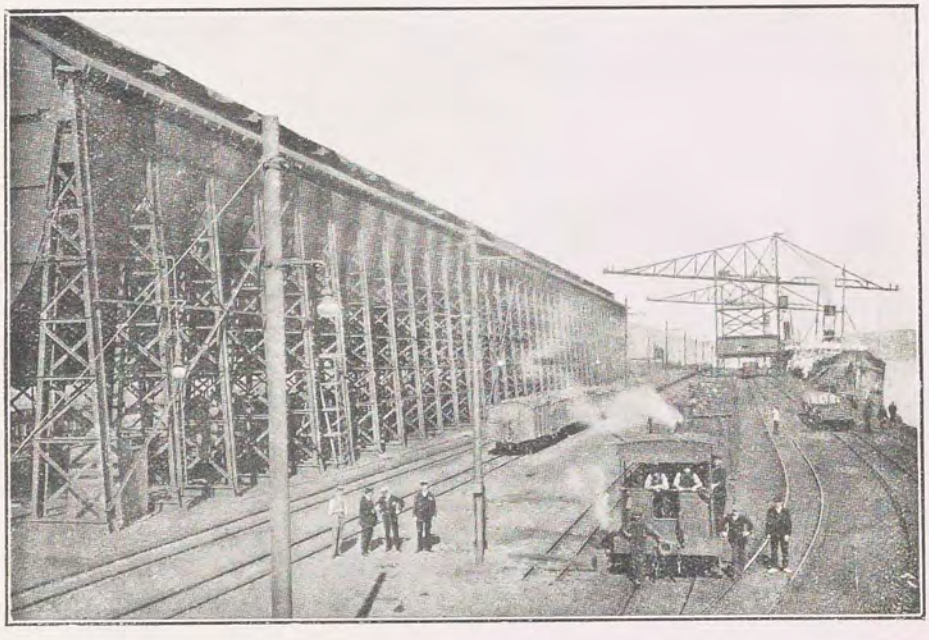
WHERE MOTOR SPIRIT IS MADE :
The Natalite Works at Clairwood, South Coast Line, Natal.



THE MUNICIPAL POWER STATION AT PRETORIA WEST.

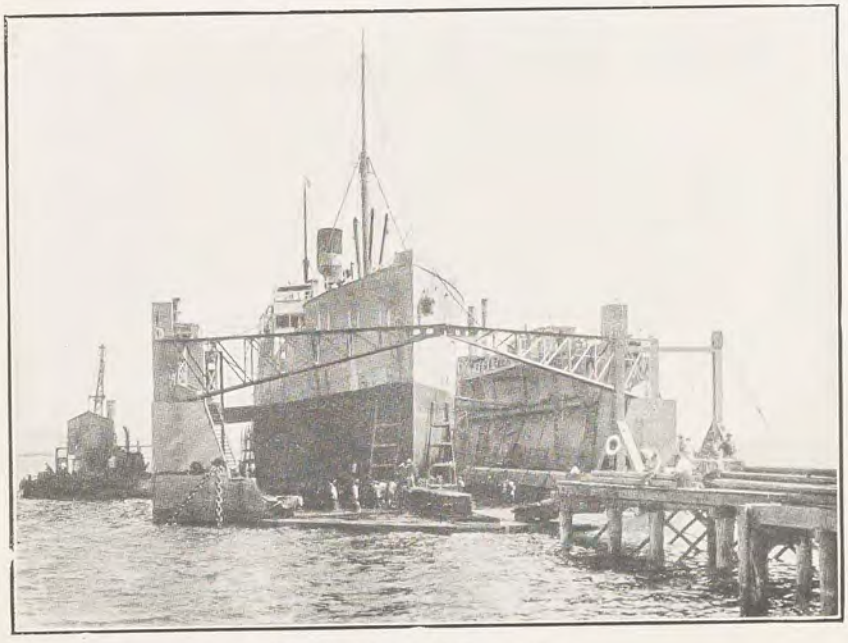


ROSHERVILLE POWER STATION.
Interior View of the Turbine House.



VIEWS OF THE COALING APPLIANCES AT DURBAN.

INTERIOR OF THE RAILWAY WORKSHOPS, DURBAN.



THE FLOATING DOCK, DURBAN.

TABLE I.—ANALYSES OF IRON ORES.

	I.	II.	III.	IV.	V.	VI.
SiO_2	0·70	12·10	17·44	5·60	9·15	3·35
TiO_2	19·20	—	Trace	0·20	—	—
Al_2O_3	Trace	—	7·38	5·90	3·77	0·50
Cr_2O_3	0·65	—	—	—	—	—
Fe_2O_3	49·40	83·65	68·11	36·30	72·41	93·50
FeO	28·50	1·90	1·32	34·30	n.d.	2·30
MnO	0·35	—	n.d.	—	—	—
MgO	1·05	—	0·47	0·60	0·76	—
CaO	0·05	—	0·75	0·70	1·70	—
P_2O_5	Trace	Trace	0·39	0·90	0·462	0·05
S	0·10	0·02	0·14	0·04*	0·068	Nil
Carbonaceous matter	—	—	—	—	4·10	—
Moisture Loss on ignition	0·70	—	4·30	0·15 5·10	6·45	0·27
TOTAL	100·65	97·67	100·16	99·29	99·71	99·97
Fe	56·74	60·07	48·60	52·09	50·69	66·23
P	Trace	Trace	0·17	0·02	0·202	0·004
S	0·10	0·02	0·014	0·39	0·068	Nil

* Determined as SO_3.

I.—Titaniferous magnetite, Rhenosterfontein No. 887, Rustenburg District, Transvaal.
II.—Iron ore, Kromdraai No. 459, Pretoria District.
III.—"Magnetic quartzite" (outcrop specimen), Pretoria Townlands.
IV.—Clay-band ore (at depth of 148 feet), Pretoria Townlands.
V.—Carbonaceous iron ore, Prestwick, 16 miles north-east of Dundee, Natal.
VI.—Hematite ore, Buffelshoek No. 151, Crocodile River Iron Fields, Transvaal.

(*a*) This is an extraordinarily persistent bed of fine-grained arenaceous oolitic ironstone ranging from 7 feet in thickness, which can be followed for hundreds of miles. It is conformably interstratified with the quartzites and shales of the Timeball Hill Zone of the Pretoria series, which near Pretoria, dip to the north at an average angle of 25 degrees. It consists of small ooliths made up of alternating concentric layers of martite, hematite, and chamosite, detrital grains of quartz and crystals of magnetite. The magnetite crystals replace oolites and quartz grains alike, and are evidently due to the recrystallisation of part of the iron oxide present.

The iron content of the rock ranges from 40.5 to 54 per cent., and the average silica content ranges from 18 to 21 per cent. The ore attains its best average grade on the Pretoria Townlands. The analysis of a representative sample is given in Table I.

(*b*) This is a thin bed of oolitic ironstone, ranging from 8 inches to 3 feet in thickness, which lies about 180 feet above the "magnetic quartzite." As developed at depth it consists of oolites, of chamosite and magnetite lying in a matrix of siderite and chamosite. Above water-level the siderite and chamosite have been oxidised to limonite and clayey matter.

and the ore has the character of an argillaceous ironstone, hence its name.

(*c*) This is made up of one or two beds of oolitic or recrystallised oolitic ironstone lying some little distance below the Daspoort Quartzite. The average grade of the ironstone is rather low, but over considerable stretches in the Potchefstroom district it ranges from 45 to 52 per cent.

Iron Ores of the Ecca Series of the Karroo System.—Thin seams and attenuated lenses of iron ore are interstratified with the sandstones and shales of the Coal Measure series (Middle Ecca) of the Karroo system at many localities in Natal and the Transvaal. They are up to 6 feet in thickness, but the average thickness is between 18 inches and 2 feet. The ore is variable in character. It may consist of soft earthy limonite and hematite, or of banded siderite, or, as at Prestwick near Dundee, Natal, of carbonaceous spathic ironstone ("black band" ore). In some localities these ores have been converted by the contact action of sills of Karroo dolerite into hard compact magnetite (Roodepoort No. 67, Ermelo District, Transvaal).

The ores are for the most part of excellent quality, but the available reserves are unfortunately very small as iron ore reserves are reckoned and probably inadequate in themselves to afford the basis of a permanent iron industry. An analysis of the Prestwick ore, above referred to, is given in Table I.

4. Important hematite deposits of the Lake Superior type, that is, secondarily enriched sedimentary ores deposited originally as sideritic cherts, occur in the Crocodile Ward of the Rustenburg District of the Transvaal, the deposits lying athwart the Crocodile River between latitudes S. 24° .35′ and 24° .40′. They take the form of lenticular or tabular deposits occurring at the base and at the top of a thick zone of banded ironstone. This is referred by some geologists to the base of the Pretoria series and by others to the top of the Dolomite. The latter view has much to support it. The individual deposits are up to 1,000 yards in length and up to 50 feet in thickness. The hematite is of exceptional purity (see Table I), and these are without doubt the most important occurrences of high-grade iron ore so far discovered in South Africa.

The ore clearly owes its origin to a process of secondary concentration whereby the original siliceous layers of certain sections of the zone of rock, that is now banded ironstone, were replaced by secondary iron oxide, giving rise to bodies of massive ore composed of alternating layers of primary and secondary hematite.

There are also extensive occurrences of the same type of ore in the Klipfontein-Thakweneng Range north of Postmasburg in Griqualand West.

The Blink Klip Breccia of Griqualand West.—Forming a special phase of this type of deposit are the very extensive occurrences of iron ore in the uppermost horizon of the dolomite series near Postmasburg in Griqualand West. They represent, according to Dr. A. W. Rogers, a concentration of iron from the originally overlying Pretoria beds along fissures and circular or elliptical areas of subsidence in the dolomite. The ore, as typically developed, is a breccia composed of fragments of banded jasper cemented together by hematite, the silica of the jasper fragments being often completely replaced by hematite. Near Postmasburg the Blink Klip Breccia, as it is termed, outcrops at intervals over a distance of 45 miles in the Gamagara Ridge. The iron content ranges from 38.1 to 67.4 per cent., and very large reserves of high grade ore are believed to be available.

Deposit on Magdala No. 818, *Zoutpansberg District, Transvaal.*—What is taken to be a highly metamorphosed deposit of the Lake Superior type was discovered some years ago on Magdala, No. 818, situated 14 miles south-east of Messina. The ore, which is of

great purity, is a massive coarsely crystalline aggregate of hematite and magnetite.

Iron Smelting Establishments.

Four blast furnaces for the production of pig iron have so far been erected in the Union. The earliest, a very primitive type of furnace, was put up many years ago at Sweetwaters, near Pietermaritzburg, for smelting the local ores of the Ecca Series. So far as the writer is aware, however, no iron was ever produced.

In 1918 small experimental furnaces were erected at Pretoria and Vereeniging.

The Pretoria furnace was operated for about 18 months, and during that period produced some 2,000 tons of iron of excellent quality. A mixture of " magnetic quartzite " and " clay band " ores from the Pretoria Series were smelted partly with limestone from Taungs and partly with local dolomite. Mixtures of titaniferous magnetite and magnetic quartzite were also tried. The furnace was erected by the Pretoria Iron Mines, Limited, with the object of ascertaining the suitability of the various ores and fluxes tested, and having satisfied themselves on these matters, operations were suspended in 1920. It is proposed as soon as adequate capital can be raised to erect a much larger furnace and steel works on the same site.

The furnace erected at Vereeniging by the Transvaal Blast Furnace Company, Limited, was similarly employed for a short time in testing mixtures of Kromdraai and Ermelo ores.

More recently a much bigger furnace, with a capacity of 150 tons of iron per diem, has been erected at Newcastle, Natal, by the Newcastle Iron and Steel Company, which has been absorbed by the Union Steel Corporation, Limited. It is proposed to smelt ore from Prestwick, near Dundee, using Taungs limestone as flux, and Vryheid and Waschbank coke as fuel. Part of the iron produced will be conveyed to Vereeniging for conversion into steel in the open-hearth furnaces there installed.

E.—COPPER.

General.—Copper occurs in the Union in the Transvaal, Cape, and Natal Provinces, but in Natal the deposits discovered have not been commercially exploitable. In the Cape Province the only deposits that have proved of much economic importance are those of Namaqualand, but at Areachap, to the west of Upington, a copper lode has been opened up in the Kheis quartz schists, whilst quartz veins carrying copper are also present in various parts of Hay, Gordonia, and Prieska, in the same and younger formations. In the Mount Ayliff district of East Griqualand, copper pyrites and pyrrhotine have also been found in association with nickel and a certain amount of platinum, along the junction of the Karroo sediments with the great mass of intrusive norites forming the Insizwa Mountain. In the Transvaal the only producer so far has been the Messina Company, operating in the Zoutpansberg District, but there are numberless ancient surface working for copper in the northern districts, and as development of the country proceeds, some at least of these will doubtless prove workable propositions. As this copper area lies in latitude 22° 15′ and at an altitude of less than 2,000 feet, it was at one time regarded as uninhabitable by white families, and in the early days the Messina Mine was frequently shut down owing to all hands suffering from malaria. Stringent anti-malaria precautions have since been taken, and it is satisfactory to note that the health conditions for several years past have been excellent, and that fever no longer causes any appreciable inconvenience.

Production of Copper.—The following table gives particulars of the value of copper sold in and shipped from the Union from 1857 :—

COPPER ORE SOLD OR SHIPPED, UNION, 1857–1926.

Year.	Cape.			Transvaal.		
	Tons.	Per Cent. of Metal.	Value.	Tons.	Per Cent. of Metal.	Value.
			£			£
1857–62	22,343	—	605,458	—	—	—
1863–82	211,500	—	4,308,433	—	—	—
1883–1903	943,658	18·99	8,336,509	—	—	—
1904	—	—	—	14	—	668
1905–09 (av.)	*	*	484,833	981	*	30,934
1910–14 (av.)	13,858†	47·30†	430,901	5,428	44·95	126,442
1915	13,973	44·48	517,208	14,996	43·38	525,106
1916	10,599	44·52	474,076	12,243	47·40	663,304
1917	10,525	47·66	550,642	9,606	51·44	575,398
1918	1,669	48·51	68,622	5,206	53·28	273,483
1919	276	74·62	17,656	4,610	60·70	216,789
1920	7,892	38·33	255,157	2,988	64·61	163,112
1921 ‡	113	72·60	5,026	45	51·27	1,420
1922 §	706	93·33	38,622	—	—	—
1923	2,846	97·19	159,713	6,613	61·03	244,798
1924	3,384	97·51	187,745	6,575	85·63	343,079
1925	2,995	98·16	160,074	6,967	86·70	354,145
1926	3,274	98·46	165,017	5,961	99·11	329,835

* No record. † Average of 1911–14. ‡ Mining practically at a standstill.
§ 3,017 tons concentrates produced in Transvaal, but treatment not completed at end of year.

In 1922, owing to the low price of copper, the Messina Mine, and to a large extent the Namaqualand Mines, did not produce, but in 1923 the Messina Mine recommenced production, and is now producing at the rate of 700 tons per month. The production of copper in the Union entirely depends on the price of the metal. It may be roughly stated that with a price of over £70 a ton the production is remunerative, but below that it is doubtful if it can be made to pay. Copper has been known to the natives from time immemorial, and there are large numbers of small ancient mines from which the metal was extracted. It is therefore doubtful whether any sensational discoveries of this metal will ever be made, though with high prices some of these ancient workings may repay opening.

F.—TIN.

Discovery and Mining of Tin.—Cassiterite was discovered both in the Cape Province and in Swaziland in the final decade of the last century, but it was not till after the termination of the South African war in 1902 that serious attention was turned to its exploitation. Later, in 1904, cassiterite was also found in the Bushveld area of the Transvaal, a discovery which has since developed in an extremely satisfactory manner, so that the Transvaal has taken its place as a permanent and important producer of tin on the markets of the world.

Three areas are now producing tin: (i) Cape Province; (ii) Eastern Transvaal and Swaziland (though this native territory is not politically incorporated in the Union, economically it has no separate existence, and is therefore mentioned in this statement); (iii) Transvaal Bushveld.

(i) Cape Province.—Cassiterite has been found at various points in the west of the Cape Province, but has only been

worked to any extent in the neighbourhood of Kuils River, sixteen miles from Capetown, on the Stellenbosch railway line. The tin is there found chiefly in association with quartz, but to a small extent also with greisen, in broken lodes traversing the granite of the Bottelary-Stellenbosch mass, close to its junction with the Malmesbury slates. Wolfram is also prominent in the lode matter, especially near the surface. These lodes have been opened up to some extent, and are said to have proved rich in places, but the very broken character of the deposits has hittherto militated strongly against successful exploitation. As the result of the denudation of the lodes, detrital accumulations of cassiterite have been found in the creeks leading down from the hills, and in the lower lying ground towards the south. This alluvial has been worked with some success, as much as 300 tons of high-grade concentrates having been reported as produced in the years 1906 and 1907.

The total tin shipped from the Cape Province up to 31st December, 1926, was 576 tons, valued at £62,482.

(ii) Eastern Transvaal and Swaziland.—The cassiterite in this area is only worked as alluvial, but it is undoubtedly derived from the many large pegmatite veins that traverse the older, or grey, granite, which here makes the escarpment of the South African plateau. These pegmatites have not yet been found workable, though cassiterite crystals are not uncommon in them. This area is subject to a very heavy rainfall and strong denudation, and in the valleys running down into Swaziland ideal conditions exist for natural concentration. The tin fields extend on both sides of the border, but at present the production of tin is entirely confined to Swaziland, where one corporation holds a practical monopoly of the stanniferous area.

The ground is worked by hydraulicing and sluicing. The cassiterite is very coarse, and no mechanical dressing is required. About half a million cubic yards of ground is annually treated, giving about 1.8 lb. black tin per yard. The value per yard is given in normal times (with tin at £139) at 2s. 2d., and the total working cost at 11.6d. The concentrates shipped carry 71 per cent. metallic tin, and are remarkably free from any deleterious impurity. Many of the rarer minerals of thorium and tungsten are found in the concentrates, but not in commercial quantities. At the present rate of working it is stated that the known deposits are sufficient for twenty years. The export from these fields is about 300 tons cassiterite per year; but this is not included in the returns for the Union.

(iii) Transvaal Bushveld.—In the central or Bushveld area of the Transvaal, cassiterite was first discovered in 1904. This area is geologically notable as consisting of an immense lacolite of red granite, intrusive between the Pretoria and the Waterberg formations. With its subsidiary felsites and contact zones of metamorphic alteration this covers an area of some 250 miles from east to west by 100 miles from north to south. Cassiterite is found both in the granite and in the felsites and sedimentary rocks in direct contact with it. In the felsites the mineral occurs irregularly along joints and bedding planes, and so far the workings in this rock have never been attended with success.

In the sedimentary rocks the Rooiberg and Leeuwpoort mines have been working most successfully in fissure veins, traversing a mass of quartzites and shales, of undoubted sedimentary origin, which are enveloped in the granite. At Rooiberg these veins are vertical, and do not carry more than 1 per cent. to 1.5 per cent. of tin, but their value consists of lateral enrichments which pass off into the bedding planes of the country rock and give pockets and bonanzas of phenomenal richness. Unfortunately, these offshoots have only so far been found near the surface, none of importance having

been encountered below 100 feet. At Leeuwpoort the veins are not highly inclined, and are richer in themselves than at Rooiberg, but, on the other hand, only one notable enrichment in the country rock has been found.

Besides pyrites, specularite, and a small amount of mispickel, no other metallic minerals are of obvious occurrence in these deposits.

The character of the deposits at Rooiberg and Zaaiplaats and the methods of mining were more fully described in previous issues of the *Union Year Book* (Nos. 1 to 4).

The crushing and dressing plants on the larger mines are thoroughly well equipped and up to date. After the preliminary concentration the concentrates are calcined and redressed, the resultant cassiterite for export containing from 65 per cent. to 70 per cent. metallic tin. All the cassiterite produced is exported to the Malay States, a more favourable market for the class of product being obtained there than in England.

In 1917 the Zaaiplaats Tin Mining Company began smelting tin for consumption in the Union. This was a war measure and was successful during the War, but was discontinued in 1921, when normal conditions returned.

Smelting was also started at Leeuwpoort and was continued during the period of the War, but, owing to the impure nature of the ore, work was discontinued soon after peace was declared.

With regard to the permanence of the production of tin in the Transvaal, the area over which it occurs is so large and the difficulty of locating the outcrops of the pipes so great, that though it seems unlikely that any great expansion will occur at any one period, yet it is probable that the discovery of new properties will go on for very many years.

Production of Tin.—The production of cassiterite in the Union since 1911 has been as follows:—

PRODUCTION OF TIN IN UNION, 1911–26.

Year.	Quantity.	Value.
	Tons (2,000 lb.).	£
1911.....	3,533·729	411,871
1912.....	2,932·208	367,699
1913.....	3,671·907	436,550
1914.....	3,429·234	311,391
1915.....	3,441·353	331,420
1916.....	3,264·068	339,571
1917.....	2,678·560	346,016
1918.....	2,206·042	440,995
1919.....	1,630·168	277,925
1920.....	2,463·219	435,680
1921.....	1,424·534	139,688
1922.....	612·154	59,986
1923.....	1,424	170,337
1924.....	2,051	305,398
1925.....	1,939	304,552
1926.....	1,791	310,899

G.—OTHER METALS.

1. *General.*—The exploitation of the mineral resources of South Africa has been of such recent growth, and the expansion of the gold, diamond, and coal industries has been so rapid and so profitable, that nearly all the available capital has been devoted to those industries, and in the past it has usually been only as a matter of accident that the presence of other minerals has been recorded. In the last ten years, however, the profitable exploitation of the tin mines and of the Messina Copper Mine has turned more attention to the question of base and rare metals, and though as yet very little capital has been spent on the exploitation of these, there is every reason to hope that they occur in sufficient quantities to become a permanent source of riches to the country.

2. *Antimony.*—This occurs as antimonite in the gold reefs of the northern line of the Murchison Range in the Zoutpansberg District of the Transvaal, in a very pronounced contact zone. The reefs extend for some thirty miles. They are to a certain extent lenticular, but occurring again and again on the same horizon, and being up to 20 feet

in width, make workable masses of ore, which have been developed down to a depth of 200 feet.

The ore contains from 6 per cent. to 60 per cent. antimonite and from 3 dwt. to 1 oz. of gold to the ton. Formerly, the antimony was regarded as worthless and as preventing the working of the gold. Recently a railway has penetrated the neigbourhood, which is only some 200 miles from the port of Delagoa Bay, and a considerable quantity of hand-picked antimonite was exported during the early part of the War period. An attempt was also made to work one mine by a wet process, which included the solution of the antimonite in caustic soda and the recovery of gold from the residues by cyanide. This process, however, failed, and the mine is now shut down.

During the War period a certain amount of fused antimonite was also produced by one mine. This was reduced to antimony in Johannesburg, and was used by the South African Railways for the production of white metal. Since the declaration of peace this work has been closed down.

Antimonite also occurs and has been opened up, showing a workable mass of ore, in the Steynsdorp Division of the Barberton District.

3. *Arsenic.*—This occurs as a deleterious impurity in many of the gold mines which are situated in contact belts and in some of the tin mines. In other of the tin mines it is an essential constituent of the pipe-like chutes which carry the cassiterite. In only two cases, however, is there sufficient arsenic in the concentrates to make its recovery payable. The first of these is the Consort Gold Mine, near Barberton, and the second was the Stavoren Tin Mine.

As some £80,000 worth of arsenate of soda for sheep and cattle dips is used annually in the Union, it is very desirable that further arsenious deposits should be developed.

4. *Barium.* — The existence of barytes has been noted in the Transvaal at several points in the Bushveld area, and also at Saltpetre Kop and Spiegel River in the Cape Province, but so far there has been no attention paid to this mineral.

5. *Bismuth.*—The occurrence of bismuth has been reported in some of the gold ores of the Sabi District and in one of the tin mines (Stavoren), but neither occurrence is of commercial importance.

In 1897 a very rich mass of bismuthite, from which several tons were extracted, was found on the farm Geweerfontein No. 604, in the Bushveld Granite area of the Transvaal. A certain amount of work has recently been done on this deposit, but with indefinite results, and the work is now suspended, though indications point to the fact that this is one of the pipe-like deposits of this area from which any results may be obtained. Recently a bismuth deposit has been located on the farm Rhenosterhoekspruit No. 662 in the Waterberg district.

6. *Chromite.**—Stratiform segregations of chromitite or chromite rock have a very wide distribution in the lower part of the norite zone of the Bushveld Igneous Complex. The chromite seams or layers can generally be referred to two or more horizons and such chromite horizons have been traced in the Lydenburg and Rustenburg Districts for scores of miles.

The chromite seams range in thickness from an inch and less to 6 feet. Some of them have been proved to be continuous over a stretch of several miles. In other instances they are lenticular and do not persist for any great distance along the strike. The chromitite seams conform strictly to the general pseudostratification of the rocks of the norite zone. They are in consequence inclined at angles of from 5° to 30°.

The chromitite has, as a rule, a peculiar mottled appearance and consists of pseudo-phenocrysts of bronzite crowded with minute chromite crystals

* By Percy A. Wagner, Geological Survey.

set in a base composed of larger chromite crystals. In addition to the minerals named, subordinate amounts of calcic felspar and diallage are present. The chromic oxide content of the chromitite ranges from 28 to 49 per cent., the average being somewhere in the neighbourhood of 40 per cent. The biggest and richest deposits are in the Lydenburg District, where the chromite rock is at present being mined on the farms Mooihoek No. 147 and Grootboom No. 186. The ore averages between 42 and 46 per cent. of Cr_2O_3. In the Rustenburg District the average grade is between 38 and 42 per cent. Cr_2O_3.

A feature of the Bushveld chromite which distinguishes it from the Rhodesian chromite is its richness in ferrous oxide of which it contains from 24 to 28 per cent. The high iron content is regarded as a disadvantage so far as the manufacture of ferro-chrome is concerned. This seems to be an anomaly and one that is likely to be removed as further progress is made in the metallurgical treatment of chrome ores.

The following are analyses of two typical specimens of bushveld chromitite:—

	I.	II.
SiO_2	1·30	5·00
Al_2O_3	11·70	13·85
Cr_2O_3	46·50	44·25
Fe_2O_3	n.d.	0·50
MnO	0·65	n.d.
FeO	25·65	26·20
MgO	9·50	9·40
CaO	0·26	0·15
Na_2O	—	trace
P_2O_5	—	—
S	trace	trace
H_2O+, H_2O-	2·00	0·15
TOTAL	97·56	99·50

I.—Chromitite, Mooihoek No. 147, Lydenburg District.

II.—Chromitite, Kroondal No. 177, Rustenburg District.

Some varieties of the bushveld chromitite contain notable amounts of platinum metals.

A start was made during 1924 with the exploitation of the bushveld chromite deposits. During 1925 there were shipped 12,474 long tons, valued at £21,001. Of this total 5,477 tons, valued at £10,568, came from the Lydenburg District, and 6,997 tons, valued at £10,433 came from the Rustenburg District.

Lydenburg District chromitite containing 44.5 per cent. of Cr_2O_3 can be delivered f.o.r. Delagoa Bay at 40 shillings per long ton, and ore containing 42.5 per cent. Cr_2O_3 at 35 shillings per long ton. The available reserves are, as already indicated, very large.

Less important chromite deposits occur in association with the ancient ultrabasic rocks of the Swaziland System in the northern Transvaal.

7. *Cobalt.*—Cobalt was one of the first minerals to be worked in the Transvaal, an extremely valuable complex ore, which fetched several hundred pounds per ton, being exported from the farm Kruis River, in the north Middelburg District of the Transvaal, in the early eighties of the last century. The deposit occurred in the contact zone of the bushveld granite, but owing to its irregularity, the mine soon closed down, and has not been reopened. Several other cobalt deposits, also connected with the bushveld granites, were opened in 1906 near the railway at Balmoral. These mines were never carried to the producing stage, but, with the attention which is now being paid to this mineral, it is probable that they will soon receive renewed attention.

Some notes by Dr. E. T. Mellor, on the field relations of these Transvaal cobalt lodes, were published in the Transactions of the Transvaal Geological Society for 1915.

8. *Lead.*—Before the introduction of breech-loading arms and fixed ammunition, lead for bullets was smelted in

the Transvaal, but the introduction of fixed ammunition killed that embryo industry. Later, in 1892, argentiferous galena was mined and smelting works were erected near the present railway station of Argent, some fifty miles east of Johannesburg. Owing to the circumstances existing at that time these works were shut down in 1896. Recently they have been reopened and an up-to-date concentration plant on the flotation principle, together with modern smelting furnaces, has been erected and a regular output of lead and silver has been obtained since November, 1921. There is in this locality a small mass of intrusive granite similar to that of the bushveld, and surrounded in a similar manner with a norite margin. In this norite highly inclined galena-bearing fissures occur. These are up to a few feet in width and carry extremely rich courses of ore. Galena also occurs widely diffused in irregular deposits in the dolomite. Formerly these deposits were only exploited in a very small way to supply some local ore reduction work on the Rand. It has recently been discovered, however, that some of these deposits in the outcrop at least are rich in vanadium.

9. *Mercury.*—Traces of native mercury have been reported from various parts of the country, but most of these are probably due to accidental salting. In the Barberton District cinnabar occurs in the contact zone between the sedimentary formation and the granite that is intrusive in it. The quantity of cinnabar in the ore (an altered quartzite) appears almost payable. The claims containing the deposit have been held for years and a good deal of money spent in developing them, but so far no attempt actually to extract the mercury has been made.

10. *Manganese.* — Manganiferous earth of inferior quality is of frequent occurrence in the Transvaal. Pyrolusite of good grade occurs in the form of veins in the older rocks of the Cape Province and in the neighbourhood of Pretoria, but the veins are in all cases small and much mixed with gangue. In the Krugersdorp District, on the farm Elandsvlei, and on neighbouring farms, there are large lateroidal deposits of high-grade pyrolusite from which cobbed ore containing 59 to 63 per cent. MnO_2 can be obtained. These deposits, which occur in areas from which the dolomite has been almost but not quite denuded, appear to be of very considerable extent, and are easily mined. Supplies of this mineral quite equal to any local demand which may spring up, will therefore be obtainable at an economic price, but it is doubtful whether it will be possible to develop a profitable export trade.

In the *Journal of Industries* for January, 1919, appears a summary of the distribution of manganese ores in the Union as known at that date. More recently an important new supply was discovered west of Kimberley, stretching for some 40 miles from Postmasburg northwards along the Gamagara Ridge. The bulk of the ore is compact very hard psilomelanes, containing 42 to 58 per cent. of metallic manganese, no phosphorus and up to 7 per cent. of silica; the ore forms a sheet interbedded in the slates of the basal portion of the Matsap Series and up to 20 feet thick. The ore is very hard and in excellent physical condition for export. Very large quantities to be reckoned in millions of tons are available. This occurrence is very promising; a detailed description will be found in Vol. 29, 1926, of the Transactions of the Geological Society of South Africa.

11. *Molybdenum.*—This occurs in Natal as molybdenite, disseminated through a horizontal sedimentary sandstone of Karroo age in the neighbourhood of certain igneous intrusions, but its extent is not yet known. It also occurs in the northern Transvaal and in Namaqualand, disseminated through pegmatite veins in the granite and gneiss, also in the tin pipes of the bushveld area.

So far this mineral has not been sought for, nor have occurrences been developed, and it is quite possible that payable deposits may be found if attention is directed to it.

12. *Nickel.* — The occurrence of nickel has been noted in many parts of the Transvaal Bushveld Complex, in the Barberton area, in the Cape Province, and also in Natal, but the only three deposits which appear at the present time to have prospects of economic importance are those at Insizwa in the Cape Province, at Vlakfontein No. 902 in the Rustenburg District of the Transvaal, and in the Barberton District. At Insizwa and Vlakfontein the ore occurs as pyrrhotite mixed with calcopyrite and pentlandite, and is apparently formed by a magmatic concentration in the base of large norite sheets.

At Vlakfontein a considerable amount of prospecting has been done, and the results justify further work, but this is unfortunately beyond the means of the present owners, who are attempting to get more capital into the venture.

The Vlakfontein deposits are fully dealt with in Geological Survey Memoir No. 21 by P. A. Wagner.

At Insizwa development is proceeding by means of a long adit calculated to tap the deposit at depth, but this adit has not yet reached its objective.

At Barberton a sedimentary bed has recently been discovered carrying a nickel ore of up to 25 per cent. The bed is up to 3 feet in thickness, and though not yet developed, appears to be permanent in character. The ore appears to occur in the form of an entirely new mineral—a magnetic iron-nickel oxide. Sulphur is absent, and the mineral reduces easily and runs down into a metallic button carrying about 54 per cent. nickel. If the deposits open up well, the mine should prove valuable.

A full description of the occurrences of nickel known in the Union at that date, and of these deposits in particular, appeared in the *Journal of Industries* for November, 1919, while a preliminary report on the Barberton occurrence was published in the same *Journal* for June, 1920.

13. *Osmiridium.*—This rare mineral is contained in the auriferous conglomerates of the Rand. It is referred to at some length in the section devoted to the platinum metals.

14. *Platinum Metals.**—It has been established during the five past years that the Union of South Africa has vast reserves of the platinum metals, and there is every prospect of her becoming ultimately the chief producer of these metals.

The main sources of supply actual and potential are:

(1) the gold-bearing conglomerates of the Witwatersrand;
(2) the magmatic and contact metasomatic deposits of the Bushveld Igneous Complex.

They will be dealt with in the order given.

(1) Platinum metals to the value of over £170,000 were recovered during 1925 on the Witwatersrand as a by-product of gold mining. They are contained in the "osmiridium" concentrate recovered on the corduroy and blanket tables that have replaced the amalgamation plants formerly employed on the Rand mines. The concentrate is at present the chief source of the world's supply of iridium. It consists of a number of different minerals and contains from 28 to 35 per cent. of iridium, 32 to 39 per cent. of osmium, 9 to 15 per cent. of ruthenium, 6 to 11 per cent. of platinum, and from .1 to .5 per cent. of rhodium. In addition small amounts of gold are invariably present. The concentrate is shipped to England. In 1925 it realised an average of £28 per oz. and in 1926 an average of £15.

The total quantity of "osmiridium" contained in the conglomerates of the

* By Percy A. Wagner, Geological Survey.

Witwatersrand System must be enormous. The available reserves though large, are limited by the fact that it would never pay to recover the concentrate except as a by-product of gold mining. The output will thus necessarily remain proportional to the output of gold on the Witwatersrand, and in particular to that of the mines working the more productive sections of the Far East Rand where the bulk of the "osmiridium" comes from. It will eventually decrease *pari passu* with the decline of gold production in that area.

(2) *The Platinum Deposits of the Bushveld Igneous Complex.*—These are by far the greatest primary platinum deposits ever discovered, and their true magnitude does not as yet appear to have been realized by engineers and financiers in Europe and America.

The Bushveld Complex itself is a vast body of plutonic and volcanic igneous rocks occupying an area of some 15,000 square miles in the central Transvaal. It consists in its outer or lower portion of norite and allied rocks, and in its inner or upper portion of granite, granophyre, and felsites. The platinum deposits are contained in the norite which is in the form of a great basin-shaped sheet. All the important occurrences so far discovered are confined to the lower portion of this sheet. They are of four main types, namely:—

(*a*) Hortonolite-dunite deposits;
(*b*) Chromitite deposits;
(*c*) Deposits in which platinum is associated with magmatic nickel-copper-iron sulphides;
(*d*) Contact metasomatic deposits in altered dolomite and sheared banded ironstone immediately underlying platinum-bearing norite and pyroxenite.

In addition to these primary deposits there are also eluvial and alluvial deposits.

(*a*) *Hortonolite-dunite Deposits.*—These take the form of pipe or parsnip-shaped segregations of hortonolite-dunite in olivine-dunite and diallagite-pegmatite. A considerable number of deposits have been found, but so far only three have been proved to be worthy of exploitation. They are situated in the western part of the Lydenburg District, on the farms Onverwacht No. 330, Mooihoek No. 147, and Driekop No. 170. A fourth occurrence, which is giving promising platinum values, has recently been found on the farm Mooihoek No. 147, in close proximity to the one above referred to. It is too early, however, to express a definite opinion on it.

The most important occurrence is that on the farm Onverwacht No. 330, the property of the Transvaal Consolidated Land and Exploration Company, Limited. It measures 60 by 60 feet at the surface, the outcrop being roughly circular. It has been followed to a depth of 250 feet and clearly extends far below this. It is becoming gradually smaller in depth, and apparently has the shape of a very elongated parsnip. The platinum content of the dunite varies from 1 dwt. to 1,213 dwt. per short ton, the average being probably between 10 and 15 dwt.

A plant capable of treating 3,000 tons per month has been erected, and is now producing about 850 ounces of platinum sponge per month. This is being sent to England for further refining.

The dunite occurrences on Mooihoek and Driekop which are the property of the Lydenburg Platinum Areas, Limited, are also being actively developed. A treatment plant with a capacity of 1,500 tons per month, which deals with the ore of both occurrences, has been completed and is producing an average of 350 ounces per month of platinum metals.

(*b*) *Chromitite Deposits.*—Reference has already been made to the chromitite seams occurring in the lower part of the norite zone. It had been known for years that the chromitite in places carries small amounts of platinum, and fairly high assays were

occasionally recorded. Speaking generally, it was found impossible to repeat such assays, and up to six months ago no occurrence had been located that gave consistent platinum values over even a short distance. Recently, however, there have been opened up in the extreme northern part of the Lydenburg District on the farm Zeekoegat No. 312 and Forest Hill No. 342, two considerable stretches of platinum-bearing chromitite which, wherever sampled, have given assays of from 1.5 to 12 dwt. per short ton. The deposits are being systematically tested.

(*c*) and (*d*). *Deposits in which Platinum is associated with Magmatic Nickel-copper-iron Sulphides and Contatct Metasomatic Deposits.*—Here belong the huge deposits on the Merensky and Main Potgietersrust horizons. The former has been traced at intervals for a distance of 90 miles in the Pietersburg and Lydenburg Districts, and for a distance of over 120 miles in the Pretoria and Rustenburg Districts.

As developed in the Lydenburg District the Merensky "reef," as it is popularly termed, is a remarkably persistent inclined sheet or layer of pseudoporphyritic pyroxenitic diallage-norite carrying small disseminated sulphide specks, or secondary minerals derived from the sulphides. The sheet ranges in thickness from 3 to 35 feet and has an average dip of 14°. Where thin, it carries platinum throughout; where thick, that mineral is generally concentrated in its uppermost portion.

In the Rustenburg District the platinum-bearing layer ranges from 3 to 6 feet in thickness and is composite in character. It consists in its upper portion of light-coloured pseudoporphyritic diallage-norite. This merges downward into pseudoporphyritic pyroxenitic diallage-norite or felspathic pyroxenite underlain, as a rule, by a thin seam of chromite-rich norite or chromitite, known as the "chrome band." The "reef" proper is everywhere underlain by a sheet of spotted anorthosite. This in places carries notable amounts of platinum to a distance of from 6 to 30 inches below the "chrome band."

The platinum content of the Merensky "reef" ranges from 1 dwt. to 246 dwt. per short ton. In the Lydenburg District it has been proved over miles to average between 2 and 3 dwt. per ton. Shorter stretches carry higher values. Thus on Onverwacht No. 330 a sector 900 feet long averages 5.5 dwt. over 48 inches. On the adjoining farm Winnaarshoek No. 349 an even more promising stretch has been opened up. In the Rustenburg District the average platinum-content appears to be higher than in the Lydenburg District. One 18,000-ft. stretch on the farms Klipfontein No. 538 and Kroondal No. 177, sampled at intervals of from 300 to 450 feet was found to average 6.5 dwt. over 38 inches.

The Main Potgietersrust Horizon, which has been traced for a distance of over 20 miles in the portion of the norite zone trending north-north-westward from Potgietersrust, is probably the equivalent of the Merensky Horizon. It consists of a thick sheet of pseudoporphyritic diallage-norite enclosing big lenticular bodies of coarse-grained felspathic bronzitite. Only the latter rock and a coarse-grained hornblende norite into which it passes locally carry notable amounts of platinum. On Sandsloot No. 276 the entire thickness of the horizon amounting here to 143 feet is occupied by these rocks. The uppermost 80 feet average over 3 dwt. of platinum per ton.

On the adjoining farms Vaalkop No. 256 and Zwartfontein No. 121 the ore horizon has the same characteristics, but here it rests on dolomite or more correctly, calc and magnesia silicate rocks derived from dolomite. These rocks for a considerable distance from the igneous contact have suffered impregnation with platinum and sulphides, so that we here have magmatic deposits in juxtaposition with contact

metasomatic deposits. In trench No. 1 on Vaalkop, where the composite ore body has been carefully sampled, it averages 7 dwt. over a width, measured horizontally, of 100 feet. On Zwartfontein are among the most iming values have been obtained. The platinum deposits on Vaalkop and Zwartfontein are among the most important so far opened up in the Bushveld Complex.

Available Reserves.—From the nature of the deposits on the Merensky Horizon it is to be expected that platinum values of the order of magnitude of those obtained at the surface will be found to persist to the greatest depth ever likely to be reached in mining. This and the figures previously given will make it clear that the available reserves of platinum-bearing rock on this horizon are practically unlimited.

Treatment of the Ores.—A pilot plant with a capacity of 100 tons per diem, using oil flotation in conjunction with all-sliming, has been in operation on the Potgietersrust Fields for some time past. Results so far have been disappointing, the percentage extraction of the platinum metals being only about 65 per cent. It is proposed, however, to modify the process by removing the coarse particles of platinum by mechanical concentration as a preliminary to sliming the ore. It is hoped by this means to obtain a much better extraction. As soon as this is accomplished large treatment plants are to be erected. The most important will be at Rustenburg.

15. *Silver.*—The only silver won has hitherto been that contained in the gold bullion, of which it forms about 10 per cent. by weight. The opening of the lead mines near Argent, which are known as the Transvaal Silver Mines, added considerably to the silver production, the galena of these mines carrying up to 80 oz. of silver to the ton. Unfortunately the amount of workable ore contained in these deposits proved to be limited and operations were suspended during 1925.

16. *Sulphur.*—There are no sulphur deposits of anything but scientific interest in the country, nor are any large deposits of massive pyrites known, except at Areachap in the Cape, near Upington. This mine, however, is in such an inaccessible position that its product cannot hope to compete on equal terms with the imported article.

There are many gossan outcrops in the older formations of the country which have not yet been opened up, and which may lead to sulphide deposits of magnitude. At present the auriferous concentrates from certain mines constitute the only source of sulphur for the sulphuric acid works attached to the explosives factories. These concentrates carry up to 45 per cent. sulphur, with about 1 oz. of gold to the ton. The supply at present is only some 250 tons per month, while the demand is at least 1,500 tons, the balance being made up by importation.

A comprehensive article on this subject appears in the *Journal of Industries* for November, 1920.

17. *Thorium.*—Monazite occurs in many places in more than samples around the margin of the Transvaal Bushveld Complex, as do various other rare minerals; but no attention has so far been paid to these, though the monazite is reported to have very distinct radioactive qualities. The mineral is also found along with cassiterite in the alluvial workings of Swaziland.

18. *Titanium.*—Samples of almost pure rutile have been obtained from the Barberton District, but no information is available as to its method of occurrence. In the Zoutpansberg District a considerable quantity of rutile occurs in the form of irregular lumps up to 50 lb. or more in weight in the elluvial soil which is being worked for corundum. Given a market for this mineral it could probably be obtained

in merchandisable quantities. The titaniferous iron ores of the Transvaal Bushveld, already mentioned, contain up to 14 per cent. titanium and occur in enormous quantities.

19. *Tungsten.*—Specimens of wolframite have been obtained from various localities in the Transvaal and from the Kuils River tin mine, but no quantity has been discovered. Scheelite occurs in considerable quantities in the Stavoren tin mines, and about 50 tons were recovered during the War period. The scheelite occurs quite irregularly mixed with tin and the associated minerals in pipe-like deposits. It may be the predominant mineral or may be entirely absent. It is not likely that any large quantities of this mineral will be obtained, but it is probable that a small output will always accompany that of tin.

A small quantity has been won in the neighbourhood of Leydsdorp.

20. *Vanadium.*—This mineral has been found associated with the lead ores of the Marico District in quite considerable quantities. So far it is impossible to say much about the prospects of successful mining, but it appears certain that there are at least several hundred tons of vanadinite in the old dumps and visible in the surface workings which can be extracted at a good profit. In April and May, 1923, there was a production of 54 tons of concentrates, containing about 7 per cent. of vanadium.

21. *Zinc.*—Zinc, like lead, occurs in irregular deposits throughout the dolomite area of the Transvaal, but, with the exception of one property, no attention has been paid to its occurrence. At Witkop, in the Marico District, a zinc mine was opened.

22. *Radio-active Minerals.*—So far pitchblende has not been found in the Union, and, with the partial exception of monazite, no commercial attention has been paid to the rarer radio-active minerals which are found in the neighbourhood of the Swaziland and Transvaal tin fields, and which were described by Dr. A. W. Rogers in a paper read before the Geological Society of South Africa in April, 1915.

H.—NON-METALLIC MINERALS OTHER THAN COAL.

General.—The previous remarks as to the lack of interest taken until recent years in the occurrence of any other minerals but diamonds and gold, applies with even more force to the non-metallic minerals. Up to ten years ago, asbestos, common salt, and lime were practically the only non-metallic minerals the existence of which was noted. The present position, however, is improving, and is as follows:—

1. *Asbestos.**—Asbestiform crocidolite, commonly known as "blue asbestos," has been worked in the Cape Province for over twenty years, having been first brought upon the market by the Cape Asbestos Company, which was formed for the purpose in 1893. For many years this company continued to be the only channel for production, and operations were largely confined to its mines in the Prieska and Hay Districts. More recently a large number of independent producers have entered the field, and the fibre now reaches the market from various sources.

Blue asbestos is found in the lower Griquatown beds, which, so far as regards the exposures of the parent rock, may be taken as identical with the range of hills known as the Asbestos Mountains, and the continuation north of these in the Kuruman-Honingvlei Range. The mineral has been found from the border of the Bechuanaland Protectorate to thirty miles south of Prieska; and it is believed that its extension over this distance of more than 300 miles is practically continuous. The lateral range of the asbestos-bearing rocks varies from four

* See Memoir No. 12, Geological Survey, "Asbestos in the Union of South Africa," and also *Journal of Industries*, November, 1918.

to upwards of twenty miles. Only small portions of this enormous area are being exploited in the meantime; but with the further opening up of the country and improvement in facilities, an indefinitely large expansion in the production must inevitably result.

The Cape Asbestos Company has two large mines developed on normal lines, and a few other companies are also starting to mine by underground methods. Generally, however, the recovery is effected by surface quarrying. The distribution of the asbestos, both as regards the number of seams found from point to point and the length of the fibre, has been found to be very irregular, but in the general case no serious cause has been found for apprehension that the recovery will cease to be payable when underground methods have to be resorted to.

Beyond rough cleaning and classification, no preparation of the fibre is yet attempted previous to shipment to the European markets. Over some portion of the asbestos area a proportion of the material mined is found to be rusty or discoloured. The former is rejected altogether, but the latter, after the usual classification, is accepted on the market at a reduced price.

Owing to differences in classification and other circumstances it is scarcely possible to form a reliable estimate of the length of the fibre being produced, but it is believed that nearly 25 per cent. of the whole production is of the length of 1 inch or over. It is equally difficult to arrive at an estimate of the asbestos yielded per ton of rock mined, but the proportion certainly exceeds that of most of the other producing fields of the world.

The crocidolite variety of asbestos differs greatly from the white or chrysotile in respect of its relatively high iron and low magnesia and water content, and naturally essential differences in its commercial qualities are disclosed. The greater resistance offered by the white variety to very high temperature is unquestioned, as also is its greater softness, making its milling and reduction much easier than in the other case. On the other hand, the crocidolite, amongst other virtues peculiarly its own, is credited with higher efficiency as an insulating material, both as regards heat and electricity, and with being unaffected by ordinary acids, chemical solutions, and, in particular, by sea-water. The fibre is also lighter, and is claimed to be at the same time stronger, finer, and more elastic. It is mainly upon how far these qualities that are claimed for blue asbestos approve themselves in the world's markets that the future of the industry in South Africa is dependent.

In the North Lydenburg District of the Transvaal, and stretching into the southern portion of the Pietersburg District, asbestos occurs over a large area in the form of interbedded veins in a highly ferruginous metamorphosed shale in the lower Pretoria Series, which is considered to be geologically identical with the Griquatown formation of the Cape Province. The extension of the mineral is very considerable, as it has been found to occur over an outcrop length of about sixty miles. Difficulty was at first experienced in getting the market to accept this variety of asbestos, but it has now been taken up both in America and Europe.

The main mine at Penge has now been opened for some 2,500 yards along the outcrop and 400 feet in depth. The average section of asbestos in this area is certainly 9 inches, and the quality appears to improve with depth. Nearly forty miles away on the same line a similar section has been exposed, and there seems every reason to believe that these fields will rank with the best in the quantity of available mineral. The quality of this asbestos is, however, different from any in the market. A very large proportion is over 4 inches in length, and this has so far proved an objection, as factory

machines are arranged to take short fibre. In the course of time suitable machinery will doubtless be erected, but at present the fibre at Penge is actually being cut into short lengths to suit the market. The composition of this asbestos, known as "amosite," is different from the ordinary crocidolite variety, being higher in iron. In texture the mineral, though fine and easily fiberized, is harsher to the touch than the Cape variety, but the fibres are quite as strong and to a certain extent elastic. As this fibre can be put on the market at a very much lower price than any similar material and occurs in extremely great quantities, it is certain that it will in the future create its own market. In the meantime the market is restricted, though a local use for the waste qualities is being found in the manufacture of asbestos tiles at a factory at Capetown.

The chrysotile deposits of the Carolina District have been known in the market for many years. The mineral is there found in veins in a bed of noble serpentine, over a length of outcrop of some twenty miles. The fibre is of excellent quality, and commands a very high price, but working conditions have not hitherto proved favourable, and production has been small and spasmodic.

Chrysotile asbestos of very good quality, equal to the best Rhodesian, has recently been discovered at Kaapsche Hoop, in the Barberton District, some twelve miles from Godwan River Station.

The deposits stretch for three or four miles and are permanent in depth; they are under active development by a number of companies, the principal being New Amianthus, Limited, and Munnik-Myburg Asbestos Company, Limited. The monthly output is now over 600 tons and the very large quantities of superior fibre available promises an increasing output from these fields.

The Northern Transvaal has recently furnished an important deposit of so-called asbestic, situated to the west of the Messina Railway. This is a massive form of lime silicate-hornblende. Though this material is not adapted for spinning, it is suitable for the manufacture of sheets and other building material, in conjunction with cement or magnesia. Its comparative low value is compensated for by the large tonnage available and low cost of mining.

The following statement gives particulars regarding the sales and shipments of asbestos from the Union during the years 1918-26:—

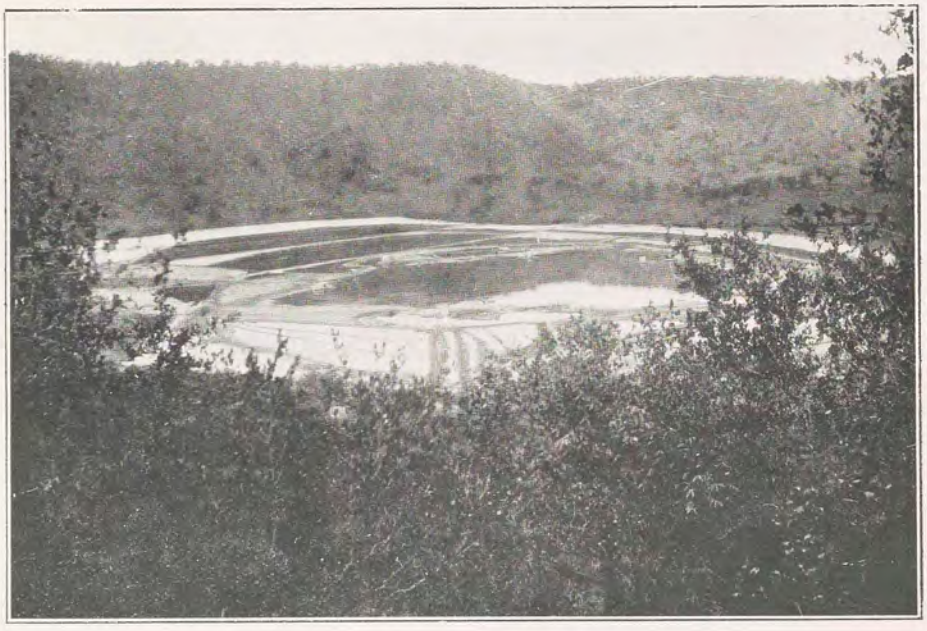
SALES AND SHIPMENTS OF ASBESTOS FROM THE UNION (SHORT TONS).

Province.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Cape	2,739	3,204	3,526	3,467	2,991	4,317	3,001	2,540	3,993
Natal	5	98	45	62	6	—	—	—	—
Transvaal	930	631	3,541	1,593	1,392	4,075	4,239	7,627	10,104

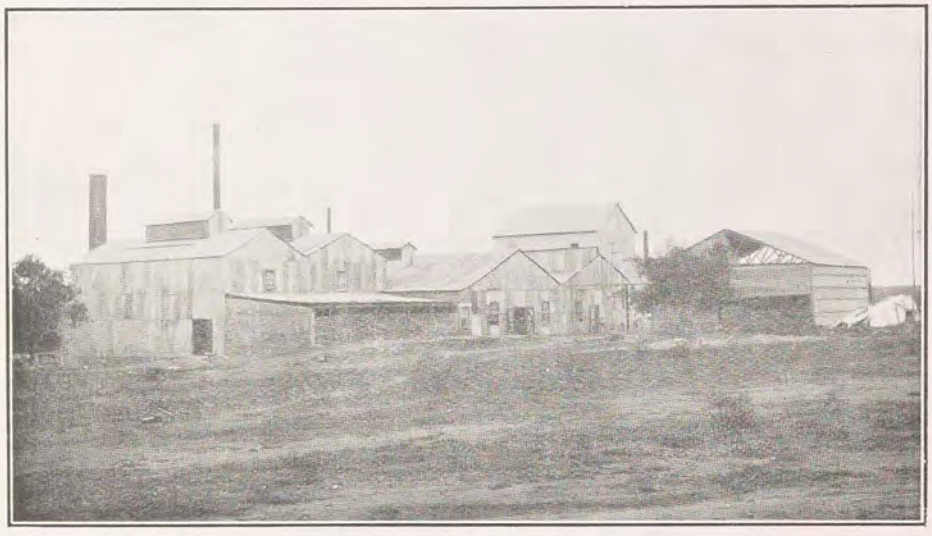
For full details see Geological Survey Memoir No. 12 "Asbestos in the Union of South Africa," and the *Journal of Industries* for November, 1918. A more recent summary of the asbestos position in the Union is (with literature and list of references) contained in the issue of the *Journal of Industries* for November, 1924.

Some of the domestic production—in particular the amosite—is consumed in the local manufacture of asbestos board and corrugated asbestos roofing of superior quality.

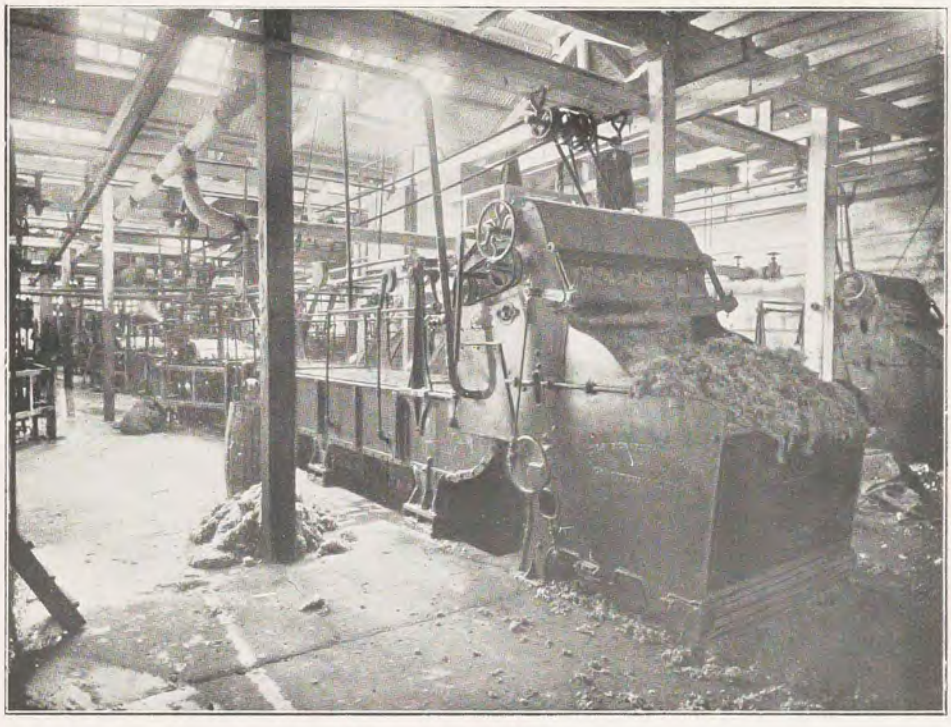
2. *Corundum.*—The existence of corundum in the gneiss and schists of the Zoutpansberg and Barberton areas has been known for some years, but



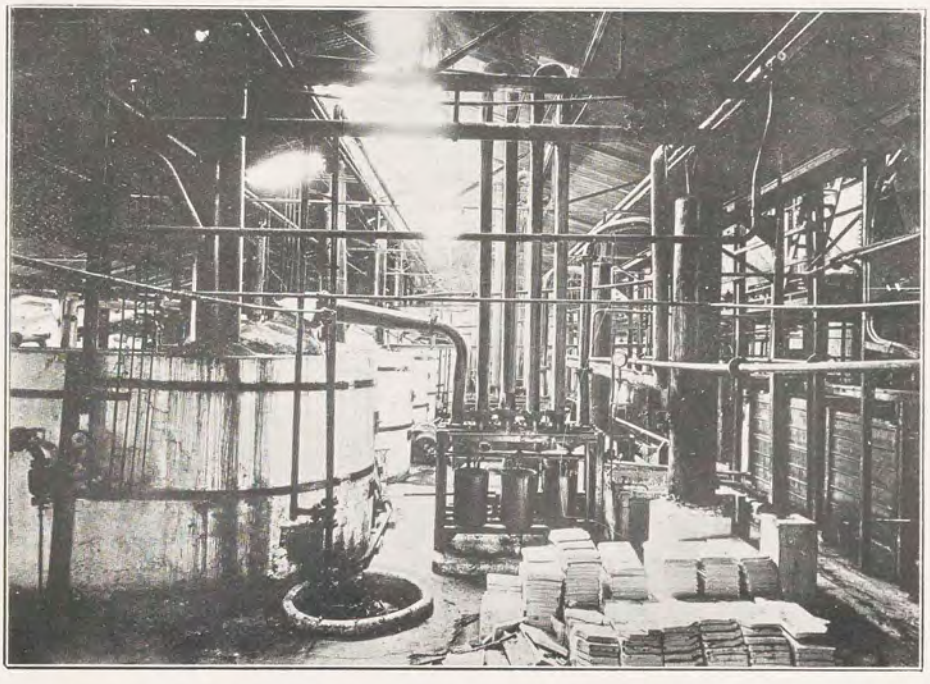
A View of the Pan.



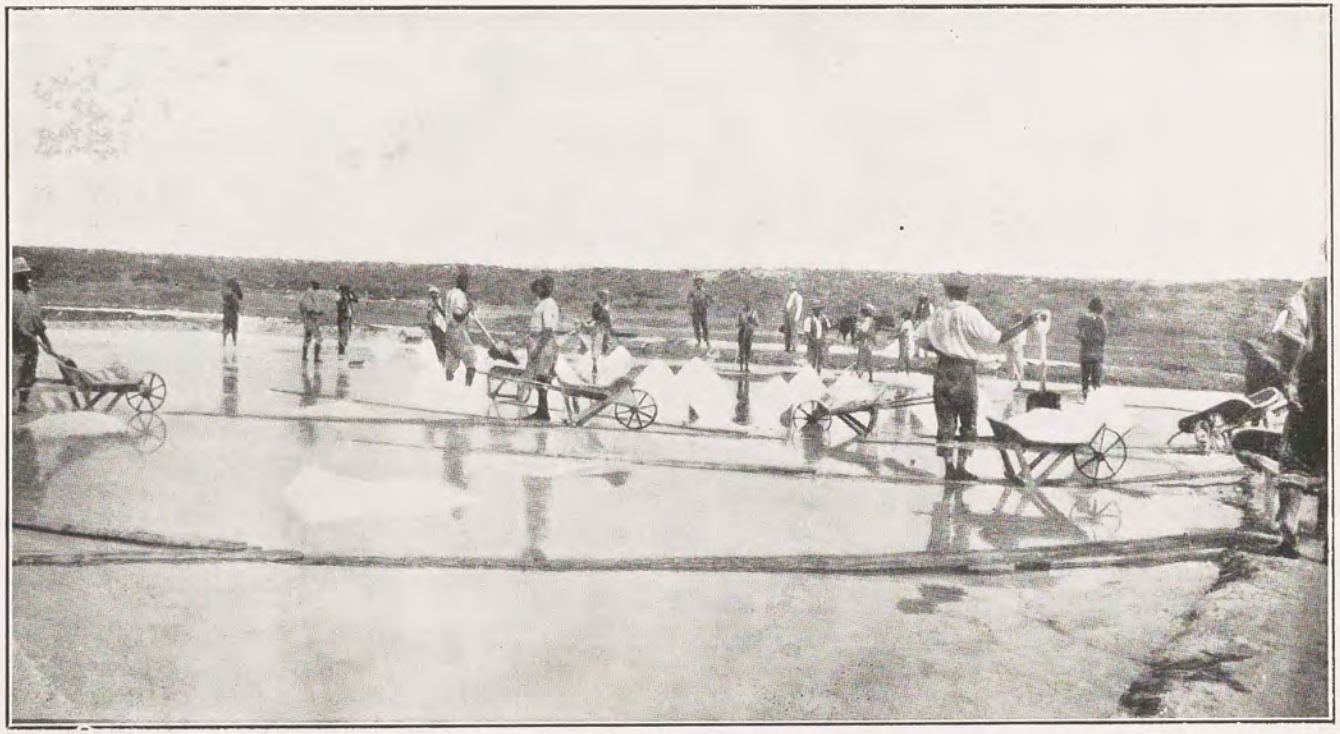
The Treatment Plant seen from the North-East, with Extractor-Tank House on right.



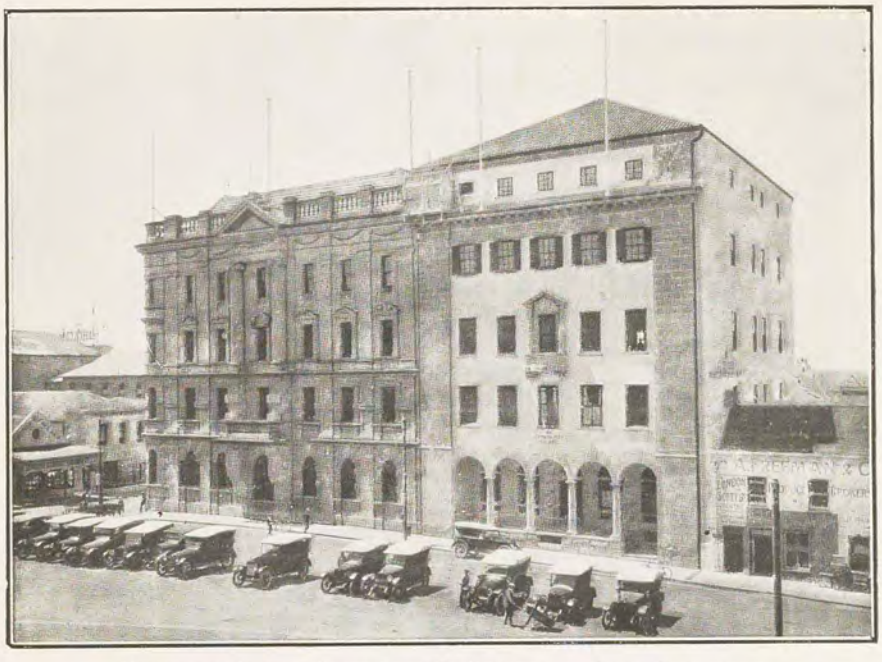
Wool-scouring Machinery.



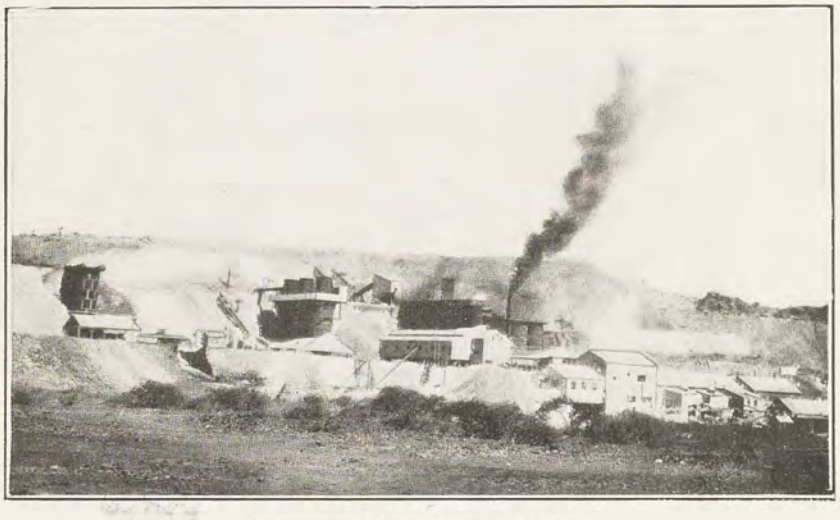
Fatty Acid Distillation Plant, South African Oil and Fat Industries, Ltd., Jacobs, Natal.



How Salt is Won from Brine Pans.



Mosenthal's and Richardson's Buildings, Port Elizabeth.



Northern Lime Works, Taungs.

was not regarded as of commercial importance till the demand for abrasives created by the European War brought it into prominence. During the War an output of up to 500 tons of crude crystal per month was maintained, but since then the production has decreased, and the present output is spasmodic, though attempts are being made to establish it in the Eupopean market.

The Transvaal Corundum Company, Limited. (formerly known as Zoutpansberg Grain Corundum Company, Limited), at Bandolier Kop in the northern Transvaal, has erected a plant to crush and grade corundum for the European and American markets. The plant furnishes grain corundum of high purity in eighteen grades, ranging from 10 to 100 meshes per linear inch in fineness. The company's products are steadily gaining increased recognition, and a steady demand may be anticipated. (For a description of their operations, see *South African Journal of Industries*, April, 1922.)

The corundum occurs in the form of broken crystals in the surface detritus derived from certain belts in the gneiss. Up to date it is usually won by screening and washing this gravel in rotary pans. The gravel is commonly up to 2 feet in thickness, and may contain 5 per cent. to 10 per cent. of corundum. The area covered by these deposits is at present quite unknown, but it is now worked at many points in a circle around Bandolier Kop not less than thirty miles in diameter. On some properties the mineral has been traced to its source in the rock. The source is an intrusive rock consisting almost entirely of felspar. The parent rock in each case appears to be interbedded in foliations of the gneiss. Apart from the crystal corundum "boulder corundum" is also found; these boulders occur in the surface drifts and in situ; they are masses containing up to 60 per cent. corundum, which, owing to their compactness, have resisted denudation. Otherwise, there seems to be no essential difference in the actual mineral. Where small enough these boulders are exported, but when too large to handle they have so far proved unworkable. Owing to the nature of the deposit and the cheap labour available, which is mostly that of native women and children, the cost of winning the mineral at the present time is not more than a few shillings per ton, but exact figures are not available. Consult *Journal of Industries*, May, 1918, and Geological Survey Memoir No. 15. A more recent summary account of the corundum position —giving list of producers and literature—appeared in the *Journal of Industries* for December, 1924. There is also a similar occurrence of corundum in the sillimanite gneiss at Steinkopf, in Namaqualand, from which a small output is obtained.

SALES AND SHIPMENTS OF CORUNDUM FROM THE UNION (SHORT TONS).

Province.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Transvaal	755	2,629	3,830	131	246	123	2,024	2,802	1,868	1,832	5,996
Cape.....	—	—	45	47	—	—	—	12	—	—	—

3. *Flint.*—Flint in the nodular form does not occur in South Africa, but as chert it makes very well-defined bands up to 2 feet and more in thickness in the dolomites. It has been worked for liners for tube-mills, but the introduction of steel and composite liners has checked the growth of this industry.

4. *Graphite.**—Impure graphite is of fairly common occurrence, both in the older sedimentary rocks and in the gneissic rocks, but so far it is only worked in one place—in the Zoutpansberg District. This little mine turns out about six tons per month. It is worked up by the owners into material for furnace linings and forge facings. The mineral occurs in a lens in gneiss; so far as opened, the deposit is over 200 feet long by 30 feet wide, and is mostly a fairly pure carbon. Certain veins in it give a very pure flake graphite, but not in large quantities.

5. *Gypsum.*—The cement factories of the Union have a constant need of gypsum, and a good deal of work has been done searching for the mineral. Up to the present the only deposits found have been irregular segregations in the soil of some valleys and pans in the more arid districts of Natal and the Orange Free State.

The chief deposit hitherto discovered in the Orange Free State is on and in the neighbourhood of the farm Vrede (part of Fouries Rust), about sixteen miles south-east of the town of Boshof. It has only been opened up at one or two points, but is said to have been proved over an area exceeding 400 acres. A thickness of from 18 feet to 20 feet has been found at one point, but this represents the maximum and the average is not likely to exceed 5 feet or 6 feet at most. The material, which is obviously the result of deposition from surface waters, is much immixed with earth, but the portion retained on a 1-foot square sieve, after being broken down and roughly cleaned, is over 90 per cent. pure. This mineral is also found along the Bloemfontein-Kimberley line, in the neighbourhood of Boschvark Siding, and at a number of other places in the Orange Free State, but the deposits have in no case been opened up to any extent and very little is yet known of them. A few hundred tons have been turned out as a by-product in the process of salt-making, and this represents a probable source of future supply.

6. *Kieselguhr.*—Kieselguhr occurs in the Amsterdam District of the eastern Transvaal, also near Krugersdorp, and in Griqualand West and Gordonia. It occurs as a deposit in the beds of certain small fresh-water marshes, and its occurrence may be very much wider, for it is not a material which attracts attention either by its appearance or its mode of occurrence. It has so far only been worked to a small extent, mainly for use in boiler-lining materials.

7. *Lignite.*—A form of lignite occurs in the Knysna District of the Cape Province, in an extensive deposit, and impure peat is fairly common in the marshes on the edge of the Transvaal and Basutoland escarpment.

Inferior coal is common in all the Karroo formations. In the Karroo horizon in the Beaufort West and Laingsburg districts of the Cape Province, veins up to 5 feet in width, both vertical and inclined, occur, filled with a coal-like substance, which appears to be an inspissated and carbonized bitumen, much in the same way as veins filled with manjac occur in the petroleum districts of other countries. This substance is not at present used, but it is of great scientific interest.

8. *Lime.*—Three forms of limestone are at present known and worked:—

(*a*) Magnesian Limestone.—This is the common dolomite which covers vast areas in the Transvaal and Cape Provinces. It contains up to 40 per cent. carbonate of magnesia. It is largely burnt in ordinary kilns, and yields the common blue building lime of those Provinces.

(*b*) White Lime.—This is a pure white lime used for chemical purposes and for the cyanide works of the Rand. It is usually obtained from stalagmitic deposits and cave-fillings in the dolomite. At Potgietersrust a small area in the dolomite has been found where the beds are free

* See *Journal of Industries*, February, 1918.

from magnesia, but the deposits are unsatisfactory in size and continuity.

At Taungs, in Bechuanaland, an extensive deposit of pure white limestone, said to contain not less than 7,000,000 tons, is now being opened up and connected with the railway. This will prove a most satisfactory development, for, up to date, there has been no adequate and suitable supply of pure limestone, for metallurgical purposes, available in the Union.

(*c*) Desert Limestone.—Vast areas in all the Provinces are covered by a desert limestone of considerable thickness. This, however, generally contains up to 20 per cent. silica and other impurities. It is largely worked near Pretoria, Mafeking, and in the Orange Free State, for cement making. For other purposes it does not generally yield a good lime.

The output of lime in the Union for 1921-22 was—

	Tons.		£
Cape of Good Hope.....	38,523	..	81,988
Natal.....	3,327	..	6,580
Transvaal.....	55,336	..	116,720
Orange Free State.....	1,266	..	4,432
UNION.....	98,452	..	£209,720

	Tons.		£
Union, 1922–23.....	114,605	..	239,992
Union, 1923–24.....	110,521	..	215,634
Union, 1924–25.....	110,562	..	216,103

9. *Magnesite.**—Magnesite in workable quantities occurs in several places in the Transvaal, notably at Kaapmuiden, where a railway traverses the deposits. It occurs as a "stock-werk" of veins in serpentine. An attempt to work it on a large scale in 1906 failed, but in 1918 the output reached an average of nearly 70 tons per month. This is used for carbonic-acid making in Johannesburg, the residue being turned into cupels. The deposits are extensive, but not continuous, and very favourably situated. At the time of the outbreak of War hopes were entertained of an export trade to America, which, however, were not realized owing to the increased freightage.

10. *Marble.*—Up to a few years ago the existence of pure marble in the Union was unknown. An inferior marble, or marmorized dolomite, occurs at Port Shepstone in Natal, but attempts to work it systematically have never been attended with success.

Of recent years attention has been called to a very considerable extent of marble at and in the neighbourhood of the farm Marble Hall, in the north Middelburg District. This marble is of great variety, and much of it is of excellent quality. It is fully reported on in the *Journal of Industries* for July, 1919. Unfortunately, this deposit is at present some seventy miles from the railway, and it has not therefore been developed, although two or three small quarries have been opened on it. With the further development of the railway system of the country, this marble will probably become of great importance—more especially as it, or much of it, gives a pure metallurgical lime, good deposits of which are very scarce in the country.

In the Cape Province marble also occurs in the coast districts of Namaqualand and Van Rhynsdorp, and a black marble at Cango. None of these deposits has, however, been opened. The railway is now approaching the Van Rhynsdorp deposits, and these will probably be exploited.

11. *Mica.*†—Excellent mica occurs in the Transvaal along the Oliphants

* See *Journal of Industries*, *March*, 1918.

† See *Journal of Industries*, March, 1918; also Geological Survey Memoir No. 13; also *Journal of Industries* for December, 1924, which contains reference to the literature and gives a list of producers.

River, below the Berg in the Leydsdorp Division of the Pietersburg District. The mica here occurs in large books up to 100 lb. and more in weight, in pegmatite lenses in the gneiss. The lenses occur in a line of country over a couple of miles in width and fifty miles long.

The mica can be cut in any size up to 12 inches, the majority of it cutting over 3 inches. It is usually slightly smoky in colour, but has excellent electricity-resisting properties. Several attempts have been made to work it. The proposition appears to be a thoroughly attractive one, but so far, partly owing to the remoteness of the fields from civilization, but more especially to the difficulty of marketing the product, these efforts have been unsuccessful. A railway now traverses the field, and it is to be hoped that when normal conditions return, the other difficulty, which appears largely due to faulty methods of grading and packing, may be overcome.

More recently a good deal of scrap and waste mica has been disposed of successfully from the Leydsdorp Fields.

Mica has also been worked on a small scale at Steinkopf, in Namaqualand.

SALES AND SHIPMENTS OF MICA FROM THE UNION.

Year.....	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Short tons.....	5·089	2·951	0·766	1·263	3·639	15·674	810*	1,612*	961

* Including scrap mica.

12. *Nitrates.*—Nitrates have been reported from all the more arid districts of the Union, but on investigation the deposits have not yet proved to be of commercial importance. An attempt has recently been made to exploit nitrate deposits of this description in the Prieska District, but it did not meet with success.

Geological Survey Memoir No. 14 gives a description of the above deposits.

The nitrate-containing brim at Matsap Pan is being investigated with the view of ascertaining its commercial possibilities.

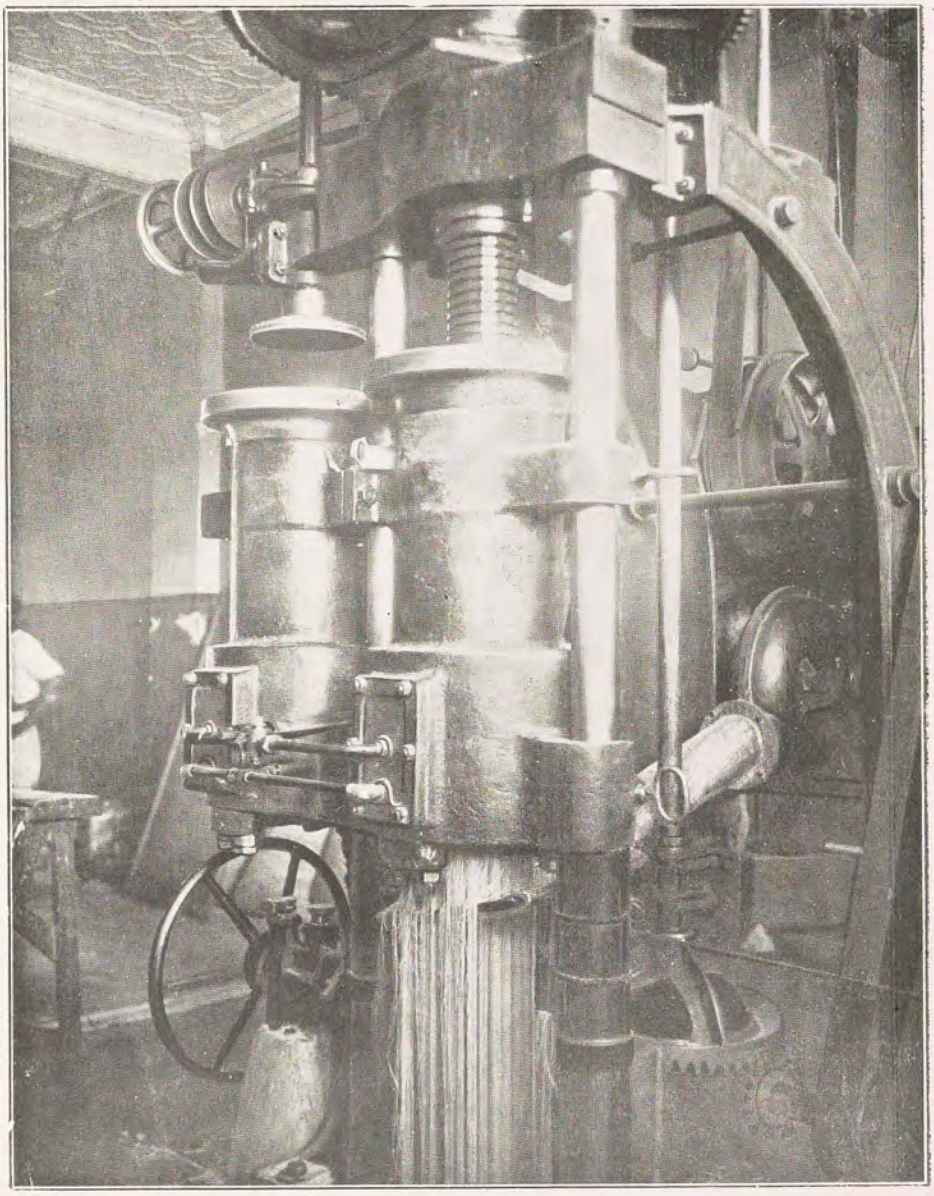
13. *Phosphates.* — No phosphates were worked in the Union until the last few years, when attention has been called to a very important group of deposits in the neighbourhood of Saldanha Bay. These are of very considerable extent, and their quantities may be estimated by hundreds of thousands of tons. An attempt made to work them during the War period met with failure, as the percentage of phosphoric acid did not come up to expectations, though the process used was successful. Since the War the price of imported phosphates has fallen to such an extent that it has not been deemed expedient to reopen the works, though in the future this will probably be done. A full report on the occurrence, by Dr. A. L. du Toit, Field Geologist to the Union Government, is published by the Geological Survey, in Memoir No. 10, 1917.

The bedded phosphates discovered near Mamre (near Capetown) have not yet been sufficiently prospected.

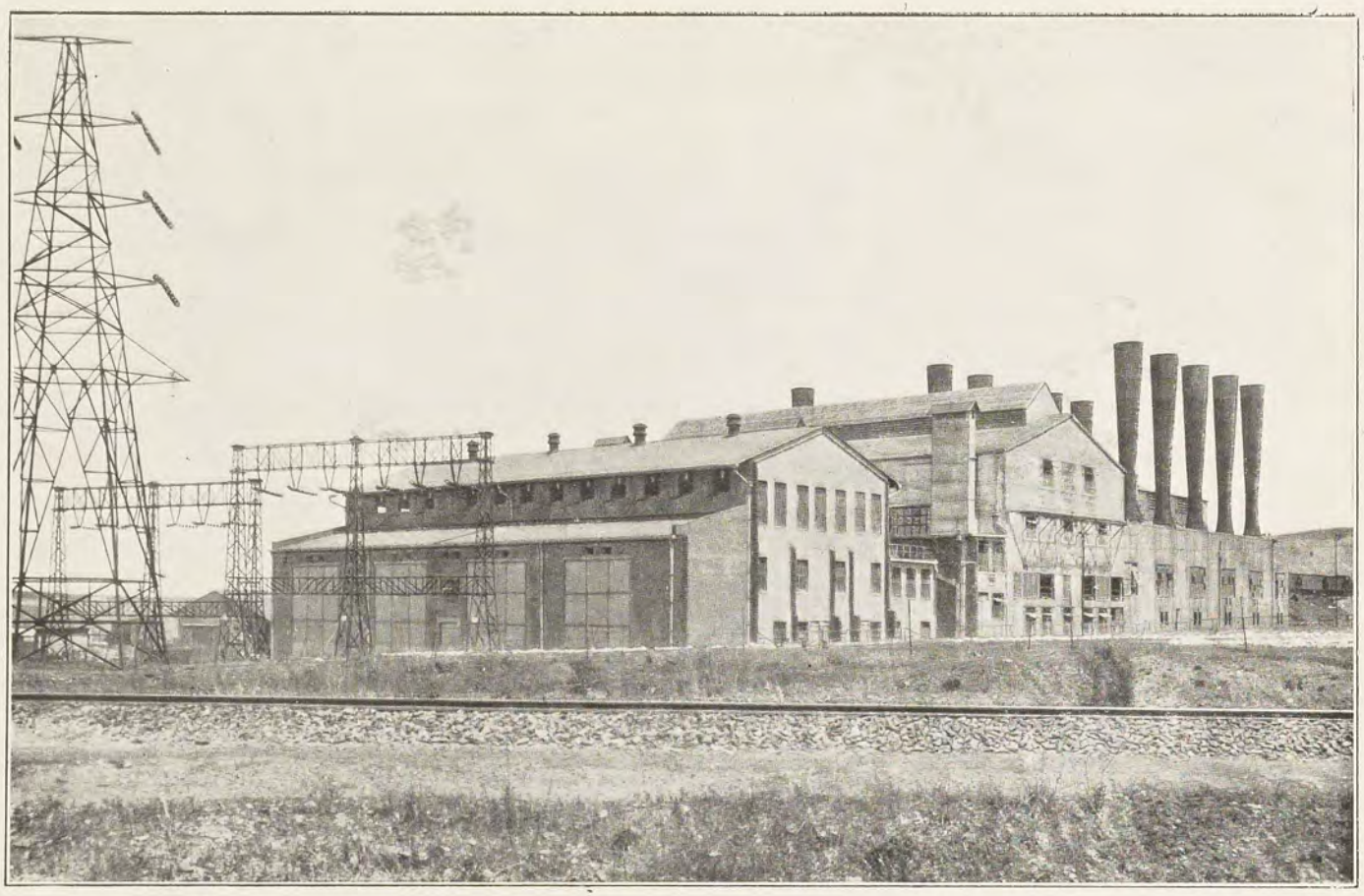
Phosphate deposits (apatite) in pegmatite in the Zoutpansberg District are under investigation.

In the Transvaal, at Lulukop, in the Zoutpansberg District, is a limestone containing some 10 per cent. of apatite, which may also become of economic value.

14. *Pigments (Mineral Paints).*—Red haematites and ochres of all descriptions, as well as specularite, occur in the older rocks of the Union.



A Press at a Johannesburg Macaroni Factory.
[Messrs. L. Fatti & Co.]



A Centre of Power Production.
The Victoria Falls Power Co.'s Station at Vereeniging.

15. *Salt.*—No deposits of rock salt are known to occur, but in the Cape, the Orange Free State, and the Transvaal Provinces a very large quantity of rough salt is made from the liquor of salt-pans. These pans are shallow depressions, often of several square miles in extent, in the surface of the more arid districts. They are without outlet and retain the inflow of water received in the rainy season, with the result that in many cases an excellent supply of brine remains available close to the surface. Such occurrences are worked now in practically every case where the brine is found to be of suitable quality and reasonable transport facilities are available. The great bulk of the salt is obtained entirely by solar evaporation in shallow dams, though in case of one or two producers, artificial heat has been adopted for final precipitation of the concentrated liquor. The coarse salt obtained by solar evaporation is subject to contamination from dust, and has to be graded in course of recovery according to its apparent quality. A portion of the purest grade is subsequently ground fine for household and dairy purposes and put on the market in suitable form. The quality of this approximates to that of the European article. The Union is now almost self-supporting in this important commodity, but new calls are likely to arise, and there will doubtless be considerable further expansion in the salt industry.

The total production in the Union in 1921-22 was as follows:—

	Tons.		£
Cape of Good Hope....	49,475	..	79,208
Transvaal.....	12,703	..	34,487
Orange Free State.....	21,384	..	34,750
UNION.....	83,562	..	£148,445

	Tons.		£
Union, 1922–23.....	68,531	..	114,225
Union, 1923–24.....	77,569	..	111,459
Union, 1924–25.....	65,333	..	105,969

16. *Soda.*—There is only one notable occurrence of soda in the Union, that at the Pretoria saltpan. This pan is a crater-like depression some 200 feet below the surrounding country, and about 28 acres in extent. The bed of the pan, from which in the dry season all the liquid evaporates, consists of a black mud containing masses of trona, or solid crude carbonate of soda. The mud, which has been proved by boreholes to be at least 200 feet deep, has the following analysis:—

	Per Cent.
Moisture at 120° C.....	50
Na_2CO_3.....	16
NaCl.....	15
$CaCO_3$.....	3
Insoluble.....	12
Organic matter.....	4
	100

Recent geological work has proved the pan to be an explosion crater, similar to those which have formed the diamond pipes, and of post-Karroo age.* The pan contains three valuable ingredients:—

(*a*) Saline mud, described above.
(*b*) Layers of trona or crystallized carbonate of soda.
(*c*) Saline liquor containing approximately 10 per cent. soda and 15 per cent. common salt.

In 1912 the South African Alkali Company started to work these deposits. For the first six years the trona only was worked, as that obviously gave the greatest immediate profit, and some 21,000 tons were won. The trona at the surface then gave out, and the company turned its attention to the mud. So far it has been found impossible to treat this, as the liquor obtained by artificially leaching the mud will not filter, neither will the impurities settle in a reasonable time.

In 1919 the original company failed, but fresh capital has been introduced and, under entirely new control, the

* See Memoir No. 20 of the Geological Survey, "Soda Caldera, known as the Saltpan near Pretoria," by P. A. Wagner.

erection of a plant, designed to produce 8 tons of soda and 16 tons of salt per day, has been completed. The sales of soda in 1926 amounted to 2,069 short tons, valued at £22,970.

17. *Talc* (*Steatite*).—Steatite of excellent quality occurs in the Barberton District, and has been noted in other areas.

Talc powder is being produced in the Barberton District, where the works are situated within easy distance of the coast. Recent developments in the neighbourhood of Malelane on the Delagoa Bay railway have established large supplies of high-grade talc, which is being ground for export. Sales and shipments amounted to 341 short tons during 1922, 355 short tons in 1923, 565 short tons in 1924, and 66 short tons during 1925.

III.—Future Prospects.

It is often stated that a mineral industry is a waning asset, and pessimists continually cry out that the zenith of production in South Africa has been passed. Theoretically there is a lot to be said for this point of view, but in actual fact it is suprising to note that even amongst the oldest countries of the world mineral production has not yet declined. For example, in Spain, since early Roman times, mining has been almost continuous, but it is probable that the mineral output of the Peninsula is to-day greater than it ever has been in the past. Tin was mined in Cornwall for centuries before the Christian era, yet tin mines still continue to be discovered in the Duchy. The fact appears to be that though the richest minerals are undoubtedly the first worked, yet the discovery of mineral deposits depends so largely on chance that it is practically impossible in any area to discover them all or to work them out in one epoch.

The future of South Africa from a mineral point of view is extremely promising. The diamonds in the known and profitable mines are sufficient to supply the market for the next hundred years, and the difficulty in this matter is not to produce but to limit production.

Apart from the known mines, fresh alluvial fields are being discovered almost monthly, and new mines are found to occur in the most unlikely spots.

With regard to gold, the future prospects of the Rand have already been dealt with, and it is obvious from the summary given, that though the production from the existing mines must gradually decline, yet the untapped areas of the East Rand will very largely compensate for this, so that though the zenith of production may have been reached, the decline will not be noticed for many years to come. Apart, however, from the existing mines which are payable to-day, there are very large areas of low-grade ore, both on the Rand proper and in the Heidelberg, Klerksdorp, and Vaal River areas, which may become payable if the purchasing power of gold appreciates, or working costs, expressed in sterling, come down. It must be remembered in this connexion that up to 1848 the purchasing power of gold was two or three times what it is to-day. From that date onwards gold was sought and discovered in all the new countries of the world, with the result that the production multiplied itself several times and the purchasing power of gold declined. It is, of course, probable that other goldfields will be discovered, but it is extremely improbable that ever again we will have such a number of great goldfields producing at the same time as has occurred in the last fifty years.

Apart from these probabilities the possibilities of further developments in the gold-mining industry are almost unlimited.

The glacial conglomerate, known as the "Dwyka," which underlies the coal measures and covers the high veld east of the East Rand like a blanket, contains many erratic blocks of highly

auriferous banket which it has left scattered around the edge of its outcrop in the Zululand and Piet Retief Districts. Where these blocks came from no one knows, but probably from under the area now covered by the coal measures of the Transvaal high veld. To seek for these areas at the present time would be unjustifiable wild-catting, but sooner or later there is the possibility of their being discovered.

For the rest, though there does not seem to be any prospect of another great goldfield being discovered in the area of the Union, there is a practical certainty that individual payable gold mines will continue to be found in the older rocks of the Moodies Series, and probably also in the conglomerate beds of the Ventersdorp System and of the, as yet, unclassified formations in Zululand.

With regard to iron, coal, and coal by-products, the proved resources of the country are literally enormous, and no one can predict the developments to which these resources will be applied, but that they will be applied is certain, for every decade that passes increases the value of coal to our civilization; indeed, civilization, as we at present know it, is based on coal and iron. These assets in the older countries of the world are certainly waning. In South Africa they have not yet been drawn on. Up to date in South Africa the base and non-metallic minerals have not been touched, and in many cases even where they have been found their presence has not been recorded in any published work. All the attention of capital has been devoted to the gold and diamond industry. To-day, with improved railway facilities and an occupied country, the possibility of working these has arrived and their development has already commenced, and in the opinion of those most competent to judge there is no economic mineral which cannot be sought for with fair prospects of success in the country. It can therefore be stated that though the mining industry on the Rand may have attained its zenith, the general mining industry of South Africa has hardly yet begun, and that the total output of minerals is certain to increase and to go on increasing for many generations to come.

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(ix) PUBLICATIONS OF THE GEOLOGICAL SURVEY.

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No. 16.—The Mutue Fides-Stavoren Tinfield. By P. A. Wagner. 192 pages, 30 plates, and 1 map. (Price 7s. 6d.)

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No. 18.—A Bibliography of South African Geology to the end of 1920. Author's Index. By A. L. Hall.

No. 19.—The Coal Resources of South Africa. Vol. I.—The Coalfields of Witbank, Springs, and Heidelberg, and of the Orange Free State. By W. Wybergh. 132 pages, 15 plates, and 3 maps. Vol. II.—The Inland Coalfields of Natal. By W. Wybergh. 180 pages, 8 figs., 6 plates.

No. 20.—The Soda Caldera known as the Saltpan near Pretoria. By P. A. Wagner. 136 pages, 6 figs., 19 plates.

No. 21.—On Magmatic Nickel Deposits of the Bushveld Complex in the Rustenburg District, Transvaal. By P. A. Wagner, 181 pages, 14 figs., 22 plates.

No. 22.—A Subject Index to the Literature on the Geology and Mineral Resources of South Africa. By A. L. Hall.

No. 23.—The Economic Geology of Sabie and Pilgrims Rest. By W. J. Wybergh. 124 pages, 18 figs., 5 plates.

No. 25.—A Bibliography of South African Geology for the years 1921-25. By A. L. Hall. 1926.

The following *Sheet Maps* have been published on the scale of 2.35 miles to the inch (1:148,752), each accompanied by an *Explanation* (price 5s. each, complete):—

Transvaal.

No. 1.—Pretoria (Explanation by H. Kynaston.) (Out of print.)

No. 2.—Pienaars River. Revised Edition (Explanation by H. Kynaston).

No. 3.—Middelburg (Explanation by E. T. Mellor). (Out of print.)

No. 4.—Rustenburg (Explanation by W. A. Humphrey).

No. 5.—Zeerust } (Explanation by A. L.
No. 6.—Mafeking } Hall and W. A. Humphrey).

No. 7.—Potgietersrust (Explanation by H. Kynaston, E. T. Mellor, and A. L. Hall).

No. 8.—Sekukuniland (Explanation by A. L. Hall).

No. 9.—Marico (Explanation by W. A. Humphrey).

No. 10.—Nylstroom (Explanation by H. Kynaston, E. T. Mellor, and W. A. Humphrey).

No. 11.—Lydenburg (Explanation by A. L. Hall).

No. 12.—Pilandsberg (Explanation by W. A. Humphrey).
No. 13.—Oliphants River (Explanation by A. L. Hall).
No. 14.—Witfontein } (Explanation by H. Kynaston and W. A. Humphrey).
No. 15.—Crocodile Pools }
No. 16.—Belfast (Explanation by A. L. Hall).
No. 52.—Johannesburg (Explanation by E. T. Mellor).

Cape.

(Scale 3.8 miles to the inch—1:238,000).

No. 5.—Laingsburg (Explanation by A. W. Rogers).
No. 27.—Maclear-Umtata (Explanation by A. L. du Toit).
No. 28.—Pondoland (Explanation by A. L. du Toit).

Special Publications.

Report on a Reconnaissance of the North-west Zoutpansberg District. By T. G. Trevor and E. T. Mellor. 40 pages and 16 plates (including 1 map). (Price 2s. 6d.)

Report on the Oil Shales in Impendhle County, Natal. By A. L. du Toit. Pretoria, 1916.

Geological Map of the Witwatersrand Goldfields, with Explanation. By E. T. Mellor. In three sheets. Scale 1:60,000. (Price: unmounted, £1. 10s.; mounted on linen, with rollers, £3. 3s.)

Geological Map of the Country round Heidelberg. Scale 1:60,000. (With an Explanation by A. W. Rogers.)

Geological Map of the Union of South Africa, on the scale of one to a million. (Explanation by A. W. Rogers.)

The following publications were issued by the Geological Commission, Cape of Good Hope, prior to the amalgamation with the Geological Survey:—

Annual Reports.

First to Fifth Annual Reports, 1896-1900. (Out of print.)

Sixth to Sixteenth Annual Reports, 1901-11. (Price 2s. 6d. each.)

Index to Annual Reports for the years 1896-1903, 52 pages.

Geological Maps.

Sheets printed in colour on the scale of 3.8 miles to 1 inch (1:238,000). (Price 2s. 6d. each.)

1. Capetown - Robertson.
2. Swellendam-Riversdale.
4. Malmesbury-Ceres.
11. Clanwilliam.
13. Beaufort West-Fraserburg.
19. Nieuwerust.
26. Barkly East.
32. Van Wyks Vlei.
33. Britstown.
40. Marydale.
41. Griquatown.
42 Kimberley.
45. Postmasburg (Griqualand West).
46. Barkly West.
49. Kuruman.
50. Vryburg.
52. Mafeking.

The above publications can be purchased either direct from the Government Printer, Pretoria; the Government Stationery Offices, Capetown and Maritzburg; or the principal booksellers throughout the Union.

(x) PUBLICATIONS OF THE IMPERIAL MINERAL RESOURCES BUREAU.

The following publications of the Bureau, obtainable at H.M. Stationery Office, London, W.C. 2, contain references to South Africa:—

Antimony.
Arsenic.
Asbestos.
Barium.
Chrome Ore and Chromium.
Coal, Coke, and By-products, Part II.
Cobalt.
Copper.
Fluorspar.
Gold.
Iron Ore, Part II, British Africa.
Lead.
Manganese.
Magnesite.
Mica.
Mining Laws of the British Empire, Vol. III, Part I.
Nitrates.
Phosphates.
Platinum.
Quicksilver.
Sulphur and Iron Pyrites.
Talc.
Tin.
Tungsten.
Vanadium.
Zinc.

(xi) MINERS' PHTHISIS.

Report of the Miners' Phthisis Commission, 1902-03. Government Printing and Stationery Office, Pretoria.

Report of a Commission appointed under the provisions of the Miners' Phthisis Allowances Act, No. 34 of 1911, to inquire into the Prevalence of Miners' Phthisis and Pulmonary Tuberculosis on Mines within the Union of South Africa, 1912. Cape Times, Ltd., Government printers, Capetown.

Reports of the Miners' Phthisis Board and Miners' Phthisis Medical Bureau, 1916-21. Cape Times, Ltd., Government printers, Capetown.

Interim Report of the Miners' Phthisis Commission appointed in 1920. Cape Times, Ltd., Government printers, Capetown.

General and Final Reports of the Miners' Phthisis Prevention Committee, 1916 and 1919. The Government Printing and Stationery Office, Pretoria.

Miners' Phthisis. By L. G. Irvine and A. H. Watt. 1912. Argus Printing and Publishing Company, Ltd., Johannesburg.

Bacteriological and Other Aspects of Miners' Phthisis. By L. G. Irvine. 1904. Reprinted from the Report of the South African Association for the Advancement of Science, Johannesburg.

The Miners' Phthisis of the Rand. By W. Watkins-Pitchford. 1916. South African Association for the Advancement of Science, P.O. Box 6894, Johannesburg.

Radiography in Its Relation to Miners' Phthisis on the Witwatersrand. By W.

Steuart. 1923. William Heinemann (Medical Books), Ltd., 20 Bedford Street, London, W.C. 2.

Silicosis ("Miners' Phthisis") on the Witwatersrand: Causation, Incidence, Pathology, Symptoms, and Radiographic Appearances. By A. H. Watt, L. G. Irvine, J. Pratt Johnson, and W. Steuart, 1916. The Government Printing and Stationery Office, Pretoria.

The Gross Characters of the Silicotic Lung. By W. Watkins-Pitchford. 1915. Reprinted from the *Medical Journal of South Africa*. The Argus Printing and Publishing Company, Ltd., Johannesburg; also the offices of the *Medical Journal of South Africa*, 81 Von Brandis Street, Johannesburg.

Silicosis and Suicide. By W. Watkins-Pitchford. 1920. Reprinted from the *Medical Journal of South Africa*. The offices of the *Medical Journal of South Africa*, Johannesburg; also the Argus Printing and Publishing Company, Ltd., Johannesburg.

Studies in Experimental Silicosis and Other Pneumonokonioses. By A. Mavrogordato. 1922. Publication No. XV of the South African Institute for Medical Research, Johannesburg.

The Ash of Silicotic Lungs. By J. McCrae. 1913. Publication No. I of the South African Institute for Medical Research, Johannesburg.

On the Nature of the Doubly-Refracting Particles seen in Microscopic Sections of Silicotic Lungs and an Improved Method for Disclosing Siliceous Particles in Such Sections. By W. Watkins-Pitchford and J. Moir. 1916. Publication No. VII of the South African Institute for Medical Research, Johannesburg.

Reports of the Select Committee on the Working of Miners' Phthisis Acts, 1916, 1917, and 1920. Cape Times, Ltd., Government printers, Capetown.

Conditions Affecting the Health of Underground Workers on the Mines of the Witwatersrand. By L. G. Irvine and D. Macaulay. 1909. The Government Printing and Stationery Office, Pretoria.

The Industrial Diseases of South Africa. By W. Watkins-Pitchford. 1914. Reprinted from the *South African Medical Record*. Record Publishing Company, Capetown.

TABLE I.

STORES CONSUMED BY THE MINES DURING THE YEAR 1926.

Classification.		TRANSVAAL.					
		Gold Mines (Large).					
		Witwatersrand.		Outside Witwatersrand.		Totals.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£
Bags	value	—	3,819	—	2,475	—	6,294
Belting (including laces and fasteners)	value	—	118,160	—	4,505	—	122,665
Boiler Fluid	value	—	3,913	—	1,219	—	5,132
Bricks, Fireclay, etc.	value	—	24,350	—	829	—	25,179
Brushware	value	—	11,585	—	536	—	12,121
Buckets	value	—	4,833	—	279	—	5,112
Building Material (Ceilings, Floorings, Doors, Windows, etc.)	value	—	16,528	—	2,082	—	18,610
Candles	lb.	5,429,737	145,298	326,880	8,890	5,756,617	154,188
Carbide	lb.	9,053,598	100,125	211,674	2,577	9,265,272	102,702
Castings—							
(*a*) Brass	value	—	39,690	—	397	—	40,087
(*b*) Iron	value	—	181,338	—	5,316	—	186,654
Cement—							
(*a*) Bags	No.	424,563	165,103	13,798	5,675	438,361	170,778
(*b*) Casks	No.	3	6	—	—	3	6
Charcoal	value	—	7	—	453	—	460
Chemicals, Assay, and Smelting Requisites	value	—	139,456	—	10,762	—	150,218
Cloth, Canvas, Blanketing, Matting, etc.	value	—	38,041	—	911	—	38,952
Clothing, Boots, and Leggings (*excluding* issues on repayment)	value	—	18,394	—	117	—	18,511
Coal-cutting Machines	No.	—	—	—	—	—	—
Coal-cutting Machine Spares	value	—	—	—	8	—	8
Coal—							
(*a*) Smithy	tons	13,397	18,657	2,821	3,725	16,218	22,382
(*b*) Steam	tons	1,352,006	813,447	48,216	39,972	1,400,222	853,419
(*c*) Other	tons	55,562	35,025	116	188	55,678	35,213
(*d*) Duff and Dross	tons	176,190	99,712	—	—	176,190	99,712
Coke	tons	1,477	4,020	227	1,199	1,704	5,219
Compressed Air (purchased)	value	—	385,348	—	—	—	385,348
Concrete Pipes, Blocks, etc.	value	—	23,050	—	11	—	23,061
Cyanide	lb.	8,971,825	285,478	595,939	24,756	9,567,764	310,234
Disinfectants	value	—	11,500	—	736	—	12,236
Electrical Machinery	value	—	501,078	—	16,249	—	517,327
Electrical Machinery Spares and Fittings	value	—	91,730	—	4,172	—	95,902
Electric Power and Light (purchased)	value	—	1,582,653	—	22,698	—	1,605,351
Explosives—							
(*a*) Blasting Gelatine	cases	7,564	20,022	930	3,067	8,494	23,089
(*b*) Gelignite and Gelatine Dynamite	cases	717,067	1,358,370	20,966	43,046	738,033	1,401,416
(*c*) Dynamite and Ligdyn	cases	8,184	13,156	4	10	8,188	13,166
(*d*) Permitted Explosives for Fiery Coal Mines	cases	—	—	—	—	—	—
(*e*) Detonators (excluding Capped Fuses)	value	—	18,966	—	3,969	—	22,935
(*f*) Electric Detonators (or Electric Fuse)	value	—	31	—	—	—	31
(*g*) Safety Fuse (excluding Capped Fuses)	value	—	58,012	—	9,365	—	67,377
(*h*) Capped Fuse	value	—	287,057	—	2,753	—	289,810
(*i*) Lighting Torches (Tyisa Sticks)	value	—	14,881	—	443	—	15,324
Fencing and Wire Netting	value	—	3,539	—	1,242	—	4,781
Ferodo and other Brake Linings	value	—	1,758	—	17	—	1,775
Fodder for Stables—							
Bran, Chaff, Mealies, Forage, etc.	value	—	25,666	—	6,997	—	32,663
Food, Coffee, etc. (supplied *free* to white employees)	value	—	11,054	—	251	—	11,305
Foods, etc. (supplied *free* to Coloured Labourers)—							
(*a*) Beans	lb.	6,469,175	34,253	98,397	681	6,567,572	34,934
(*b*) Dholl	lb.	—	—	—	—	—	—
(*c*) Rice	lb.	697,157	8,549	2,499	36	699,656	8,585
(*d*) Meal (Mealie, Kaffir Corn, etc.)	bags	567,929	369,713	44,845	35,494	612,774	405,207
(*e*) Malt and Cereals for Beer	value	—	26,148	—	710	—	26,858
(*f*) Meat	lb.	33,985,185	329,966	1,426,799	17,087	35,411,984	347,053
(*g*) Fish	lb.	965,755	14,508	—	—	965,755	14,508
(*h*) Salt	bags	7,085	2,015	921	389	8,006	2,404
(*i*) Groceries, Coffee, Sugar, Oil, Ghee, Molasses, etc.	value	—	39,251	—	1,417	—	40,668
(*j*) Sundry Food, including Bread	value	—	175,220	—	2,929	—	178,149
(*k*) Vegetables	value	—	56,563	—	677	—	57,240

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		TRANSVAAL.					
		Gold Mines (Large).					
		Witwatersrand.		Outside Witwatersrand.		Totals.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£
Foundry Requisites	value	—	464	—	—	—	464
Furniture	value	—	4,821	—	466	—	5,287
Glass	value	—	1,892	—	69	—	1,961
Hand Tools (Picks, Shovels, Hammers, etc.)	value	—	99,750	—	4,984	—	104,734
Hose Fittings	value	—	45,248	—	1,168	—	46,416
Hosing (Steam, Suction, Rock-drill, etc.)	value	—	114,341	—	3,037	—	117,378
Hospital and Ambulance Requisites (including Medicines)	value	—	54,293	—	2,053	—	56,346
Instruments and Survey Requisites	value	—	10,302	—	206	—	10,508
Iron—							
(*a*) Bar and Angle	lb.	8,732,660	89,353	279,229	2,932	9,011,889	92,285
(*b*) Galvanized	value	—	15,477	—	2,391	—	17,868
(*c*) Sheet	lb.	301,158	3,768	63,520	842	364,678	4,610
(*d*) Pig	lb.	140,297	613	1,381	15	141,678	628
Ironmongery—							
(*a*) Bolts, Nuts, Washers, and Rivets	lb.	3,467,225	57,711	111,652	2,128	3,578,877	59,839
(*b*) Screws and Nails	value	—	15,009	—	661	—	15,670
(*c*) Locks, Hinges, Staples, Chains, etc.	value	—	14,020	—	355	—	14,375
(*d*) Other	value	—	20,657	—	549	—	21,206
Lamps and Spares	value	—	11,845	—	602	—	12,447
Lead—							
(*a*) Pig	lb.	192,432	2,709	1,254	35	193,686	2,744
(*b*) Sheet	lb.	12,808	371	2,446	80	15,254	451
Lime—							
(*a*) White	bags	667,021	149,809	25,427	7,480	692,448	157,289
(*b*) Blue	bags	24,059	3,775	334	74	24,393	3,849
Lubricants—							
(*a*) Oils	gallons	444,569	84,521	20,951	4,173	465,520	88,694
(*b*) Grease and Tallows	value	—	96,513	—	3,360	—	99,873
Lubricators	value	—	4,922	—	64	—	4,986
Machinery and Machine Tools	value	—	332,179	—	67,306	—	399,485
Machinery Spares, other than electrical	value	—	348,193	—	7,800	—	355,993
Mercury	bottles	818	12,639	61	935	879	13,574
Metals (anti-friction)	value	—	21,419	—	749	—	22,168
Metals—Other (Bronze, Delta, etc.)	value	—	10,209	—	176	—	10,385
Motor-cars and Accessories	value	—	13,624	—	1,265	—	14,889
Oils, other than lubricating—							
(*a*) Transformer	gallons	13,271	2,988	960	258	14,231	3,246
(*b*) Other	gallons	184,728	12,148	117	46	184,845	12,194
Oilskin Suits and Gumboots	value	—	20,797	—	918	—	21,715
Oxygen, Acetylene, and Welding Requisites	value	—	12,219	—	370	—	12,589
Packing	value	—	44,967	—	1,304	—	46,271
Paint, Tar, Driers, etc	value	—	30,911	—	1,475	—	32,386
Paraffin	cases	12,882	10,105	568	501	13,450	10,606
Petrol	gallons	149,825	23,717	11,482	1,880	161,307	25,597
Pipes and Pipe Fittings	value	—	435,190	—	22,018	—	457,208
Rails, Crossings, Sleepers, etc	value	—	293,910	—	10,866	—	304,776
Rock-drills	No.	1,833	97,803	70	4,314	1,903	102,117
Rock-drill Spares	value	—	446,330	—	12,491	—	458,821
Ropes—							
(*a*) Wire	value	—	196,806	—	3,768	—	200,574
(*b*) Vegetable Fibre	value	—	7,291	—	354	—	7,645
Rubber—Valves, Rings, Rollers, etc	value	—	6,257	—	114	—	6,371
Sand and Stone	value	—	28,661	—	115	—	28,776
Screening	value	—	14,398	—	1,385	—	15,783
Shoes and Dies	lb.	13,149,068	101,665	269,298	3,031	13,418,366	104,696
Skips, Cages, Kibbles, and Spares	value	—	18,034	—	50	—	18,084
Soap	lb.	572,743	11,740	12,040	329	584,783	12,069
Soda	lb.	2,756,576	14,853	4,121	113	2,760,697	14,966
Stable Requisites	value	—	6,604	—	2,127	—	8,731
Stationery and Printing	value	—	66,414	—	4,109	—	70,523

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		TRANSVAAL. Gold Mines (Large). Witwatersrand. Weight or Quantity.	Witwatersrand. Value.	Outside Witwatersrand. Weight or Quantity.	Outside Witwatersrand. Value.	Totals. Weight or Quantity.	Totals. Value.
			£		£		£
Steel—							
(*a*) Bar, Tool, Cast, etc.	lb.	2,082,022	35,316	75,835	1,271	2,157,857	36,587
(*b*) Sheet	lb.	14,206,885	113,594	173,873	1,590	14,380,758	115,184
(*c*) Hand-drill	lb.	926,538	12,656	50,279	937	976,817	13,593
(*d*) Rock-drill	lb.	12,572,610	293,830	374,317	8,981	12,946,927	302,811
(*e*) Structural	value	—	27,159	—	52	—	27,211
(*f*) Other	lb.	1,152,691	13,006	3,220	75	1,155,911	13,081
Tamping (Plugs, Paper, etc.)	value	—	10,411	—	210	—	10,621
Timber—							
(*a*) Deals	value	—	73,177	—	5,510	—	78,687
(*b*) Oregon, Pitch Pine, etc.	value	—	257,439	—	5,291	—	262,730
(*c*) Mining Poles and Lagging	value	—	582,427	—	21,388	—	603,815
(*d*) Other	value	—	59,260	—	1,606	—	60,866
Transport, Railage, etc.	value	—	25,404	—	7,006	—	32,410
Tube Mill Requisites—							
(*a*) Pebbles and Flints	value	—	—	—	—	—	—
(*b*) Liners	value	—	118,860	—	2,327	—	121,187
(*c*) Other Requisites	value	—	16,797	—	573	—	17,370
Trucks and Spares	value	—	129,120	—	8,994	—	138,114
Waste, Sweat Rags, etc.	value	—	11,102	—	498	—	11,600
Water (purchased)	value	—	183,488	—	—	—	183,488
Wood Fuel	value	—	87	—	1,787	—	1,874
Zinc and Zinc Discs	lb.	4,487,646	101,917	271,706	6,317	4,759,352	108,234
Sundry Articles not specified above	value	—	41,062	—	9,171	—	50,233
TOTAL VALUE		—	13,381,409	—	562,792	—	13,944,201

Classificaiton.		TRANSVAAL. Diamond Mines. Weight or Quantity.	Diamond Mines. Value.	Coal Mines. Weight or Quantity.	Coal Mines. Value	Other Mines. Weight or Quantity.	Other Mines. Value	Totals. Transvaal Mines. Weight or Quantity.	Totals. Transvaal Mines. Value.
			£		£				£
Bags	value	—	1,001	—	1,051	—	7,442	—	15,788
Belting (including laces and fasteners)	value	—	4,231	—	3,603	—	6,531	—	137,030
Boiler Fluid	value	—	—	—	172	—	67	—	5,371
Bricks, Fireclay, etc.	value	—	961	—	6,719	—	8,389	—	41,248
Brushware	value	—	113	—	608	—	369	—	13,211
Buckets	value	—	—	—	523	—	857	—	6,492
Building Material (Ceilings, Floorings, Doors, Windows, etc.)	value	—	520	—	9,004	—	7,202	—	35,336
Candles	lb.	—	—	451,868	12,203	136,251	4,149	6,344,736	170,540
Carbide	lb.	—	—	210,034	2,615	104,058	1,575	9,579,364	106,892
Castings—									
(*a*) Brass	value	—	2,157	—	1,210	—	318	—	43,772
(*b*) Iron	value	—	5,828	—	2,344	—	567	—	195,393
Cement—									
(*a*) Bags	No.	1,295	517	8,864	3,589	17,170	7,659	465,690	182,543
(*b*) Casks	No.	—	—	—	—	4	18	7	24
Charcoal	value	—	—	—	—	—	1,738	—	2,198
Chemicals, Assay, and Smelting Requisites	value	—	—	—	236	—	7,247	—	157,701
Cloth, Canvas, Blanketing, Matting, etc.	value	—	46	—	1,903	—	361	—	41,262
Clothing, Boots, and Leggings (*excluding* issues on repayment)	value	—	420	—	631	—	149	—	19,711

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		TRANSVAAL.							
		Diamond Mines.		Coal Mines.		Other Mines.		Totals. Transvaal Mines.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£		£
Coal-cutting Machines	No.	—	—	46	6,814	—	—	46	6,814
Coal-cutting Machine Spares	value	—	—	—	11,765	—	—	—	11,773
Coal—									
(*a*) Smithy	tons	511	641	19,441	2,990	294	564	36,464	26,577
(*b*) Steam	tons	58,708	34,983	53,268	9,915	17,486	25,169	1,529,684	923,486
(*c*) Other	tons	3,946	2,558	26,958	1,819	2,596	5,606	89,178	45,196
(*d*) Duff and Dross	tons	—	—	45,030	6,211	20,319	24,198	241,539	130,121
Coke	tons	108	309	—	—	223	517	2,035	6,045
Compressed Air (purchased)	value	—	—	—	—	—	—	—	385,348
Concrete Pipes, Blocks, etc	value	—	—	—	405	—	2,944	—	26,410
Cyanide	lb.	—	—	43	5	—	—	9,567,807	310,239
Disinfectants	value	—	104	—	1,088	—	2,457	—	15,885
Electrical Machinery	value	—	1,856	—	19,479	—	47,251	—	585,913
Electrical Machinery Spares and Fittings	value	—	6,170	—	9,106	—	4,528	—	115,706
Electric Power and Light (purchased)	value	—	—	—	14,816	—	—	—	1,620,167
Explosives—									
(*a*) Blasting Gelatine	cases	—	—	240	720	1,090	3,939	9,824	27,748
(*b*) Gelignite and Gelatine Dynamite	cases	41	65	3,489	5,149	15,041	34,144	756,604	1,440,774
(*c*) Dynamite and Ligdyn	cases	20,328	27,574	23,584	33,140	363	538	52,463	74,418
(*d*) Permitted Explosives for Fiery Coal Mines	cases	—	—	8,182	12,649	—	—	8,182	12,649
(*e*) Detonators (excluding Capped Fuses)	value	—	4,561	—	5,672	—	3,325	—	36,493
(*f*) Electric Detonators (or Electric Fuse)	value	—	—	—	6,001	—	1,553	—	7,585
(*g*) Safety Fuse (excluding Capped Fuses)	value	—	15,950	—	17,125	—	8,378	—	108,830
(*h*) Capped Fuse	value	—	—	—	989	—	1,322	—	292,121
(*i*) Lighting Torches (Tyisa Sticks)	value	—	10	—	248	—	408	—	15,990
Fencing and Wire Netting	value	—	8	—	1,054	—	469	—	6,312
Ferodo and other Brake Linings	value	—	—	—	27	—	68	—	1,870
Fodder for Stables—									
Bran, Chaff, Mealies, Forage, etc.	value	—	261	—	4,630	—	1,409	—	38,963
Food, Coffee, etc. (supplied *free* to white employees)	value	—	—	—	27	—	—	—	11,332
Foods, etc. (supplied *free* to Coloured Labourers)—									
(*a*) Beans	lb.	—	—	914,842	4,680	40,300	231	7,522,714	39,845
(*b*) Dholl	lb.	—	—	—	—	—	—	—	—
(*c*) Rice	lb.	—	—	18,506	272	1,800	27	719,962	8,884
(*d*) Meal (Mealie, Kaffir Corn, etc.)	bags	1,044	797	46,249	31,516	60,148	48,138	720,215	485,658
(*e*) Malt and Cereals for Beer	value	—	128	—	2,716	—	294	—	29,996
(*f*) Meat	lb.	45,960	1,149	2,962,156	30,660	1,016,745	13,053	39,436,845	391,915
(*g*) Fish	lb.	—	—	25,300	370	—	—	991,055	14,878
(*h*) Salt	bags	—	—	1,007	300	574	225	9,587	2,929
(*i*) Groceries, Coffee, Sugar, Oil, Ghee, Molasses, etc	value	—	240	—	5,874	—	881	—	47,663
(*j*) Sundry Food, including Bread	value	—	1,046	—	20,099	—	856	—	200,150
(*k*) Vegetables	value	—	159	—	5,956	—	985	—	64,340
Foundry Requisites	value	—	595	—	2	—	22	—	1,083
Furniture	value	—	194	—	1,123	—	2,049	—	8,653
Glass	value	—	39	—	164	—	50	—	2,214
Hand Tools (Picks, Shovels, Hammers, etc.)	value	—	2,088	—	6,543	—	4,021	—	117,386
Hose Fittings	value	—	—	—	229	—	223	—	46,868
Hosing (Steam, Suction, Rock-drill, etc.)	value	—	412	—	1,164	—	1,329	—	120,283
Hospital and Ambulance Requisites (including Medicines)	value	—	1,357	—	3,343	—	2,024	—	63,070
Instruments and Survey Requisites	value	—	10	—	295	—	884	—	11,697
Iron—									
(*a*) Bar and Angle	lb.	285,632	3,364	274,875	2,530	303,421	3,688	9,875,817	101,867
(*b*) Galvanized	value	—	607	—	3,085	—	7,884	—	29,444
(*c*) Sheet	lb.	—	—	10,416	107	15,863	411	390,957	5,128
(*d*) Pig	lb.	464,955	1,471	—	—	—	—	606,633	2,099

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		TRANSVAAL.							
		Diamond Mines.		Coal Mines.		Other Mines.		Totals. Transvaal Mines.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£		£
Ironmongery—									
(*a*) Bolts, Nuts, Washers, and Rivets	lb.	143,692	2,643	206,357	3,511	93,490	2,224	4,022,416	68,217
(*b*) Screws and Nails	value	—	374	—	844	—	1,056	—	17,944
(*c*) Locks, Hinges, Staples, Chains, etc.	value	—	82	—	674	—	794	—	15,925
(*d*) Other	value	—	121	—	854	—	2,869	—	25,050
Lamps and Spares	value	—	—	—	1,142	—	413	—	14,002
Lead—									
(*a*) Pig	lb.	412	7	1,017	18	4,077	81	199,192	2,850
(*b*) Sheet	lb.	262	9	100	1	114	4	15,730	465
Lime—									
(*a*) White	bags	40	14	1,851	575	3,622	1,436	697,961	159,314
(*b*) Blue	bags	409	104	3,996	946	3,998	1,438	32,796	6,337
Lubricants—									
(*a*) Oils	gallons	25,864	4,109	60,810	10,605	31,552	7,799	583,746	111,207
(*b*) Grease and Tallows	value	—	2,427	—	8,317	—	1,296	—	111,913
Lubricators	value	—	137	—	196	—	188	—	5,507
Machinery and Machine Tools	value	—	9,748	—	27,321	—	116,520	—	553,074
Machinery Spares, other than electrical	value	—	26,021	—	13,190		25,195	—	420,399
Mercury	bottles	—	—	—	—	16	251	895	13,825
Metals (anti-friction)	value	—	1,179	—	1,020	—	749	—	25,116
Metals—Other (Bronze, Delta, etc.)	value	—	759	—	321	—	144	—	11,609
Motor-cars and Accessories	value	—	78	—	1,923	—	1,756	—	18,646
Oils, other than lubricating—									
(*a*) Transformer	gallons	40	8	869	182	310	57	15,450	3,493
(*b*) Other	gallons	—	—	4,161	774	9,032	885	198,038	13,853
Oilskin Suits and Gumboots	value	—	—	—	225	—	464	—	22,404
Oxygen Acetylene and Welding Requisites	value	—	308	—	375	—	1,669	—	14,941
Packing	value	—	438	—	1,914	—	1,105	—	49,728
Paint, Tar, Driers, etc.	value	—	719	—	2,369	—	1,644	—	37,118
Paraffin	cases	192	157	802	623	1,976	1,680	16,420	13,066
Petrol	gallons	4,200	661	29,342	4,507	75,711	11,981	270,560	42,746
Pipes and Pipe Fittings	value	—	2,114	—	18,387	—	26,733	—	504,442
Rails, Crossings, Sleepers, etc.	value	—	2,830	—	26,941	—	7,408	—	341,955
Rock-drills	No.	8	220	2	85	49	3,024	1,962	105,446
Rock-drill Spares	value	—	876	—	679	—	3,687	—	464,063
Ropes—									
(*a*) Wire	value	—	6,260	—	11,167	—	2,288	—	220,289
(*b*) Vegetable Fibre	value	—	2,038	—	303	—	284	—	10,270
Rubber—Valves, Rings, Rollers, etc.	value	—	13	—	186	—	128	—	6,698
Sand and Stone	value	—	127	—	747	—	2,024	—	31,674
Screening	value	—	22	—	810	—	1,566	—	18,181
Shoes and Dies	lb.	—	—	—	—	41,789	534	13,460,155	105,230
Skips, Cages, Kibbles, and Spares	value	—	—	—	536	—	669	—	19,289
Soap	lb.	2,050	40	29,432	583	6,694	151	622,959	12,843
Soda	lb.	850	5	100,915	610	3,888	32	2,866,350	15,613
Stable Requisites	value	—	7	—	822	—	479	—	10,039
Stationery and Printing	value	—	1,378	—	4,412	—	4,197	—	80,510
Steel—									
(*a*) Bar, Tool, Cast, etc.	lb.	9,079	488	229,376	3,826	24,490	434	2,420,802	41,335
(*b*) Sheet	lb.	292,727	2,568	368,338	3,380	192,349	2,259	15,234,172	123,391
(*c*) Hand-drill	lb.	19,657	284	21,252	569	118,871	2,170	1,136,597	16,616
(*d*) Rock-drill	lb.	4,998	114	16,349	543	79,011	2,237	13,047,285	305,705
(*e*) Structural	value	—	1,700	—	364	—	491	—	29,766
(*f*) Other	lb.	5,340	92	2,476	71	6,108	106	1,169,835	13,350
Tamping (Plugs, Paper, etc.)	value	—	—	—	1,229	—	146	—	11,996
Timber—									
(*a*) Deals	value	—	4,203	—	5,611	—	12,908	—	101,409
(*b*) Oregon, Pitch Pine, etc.	value	—	2,489	—	3,073	—	10,106	—	278,398
(*c*) Mining Poles and Lagging	value	—	719	—	4,954	—	6,574	—	616,062
(*d*) Other	value	—	99	—	852	—	1,860	—	63,677
Transport, Railage, etc.	value	—	1,389	—	4,178	—	7,355	—	45,332
Tube Mill Requisites—									
(*a*) Pebbles and Flints	value	—	—	—	—	—	52	—	—
(*b*) Liners	value	—	—	—	—	—	1,334	—	122,521
(*c*) Other Requisites	value	—	77	—	—	—	837	—	18,284
Trucks and Spares	value	—	4,533	—	16,662	—	5,671	—	164,980
Waste, Sweat Rags, etc.	value	—	299	—	803	—	553	—	13,255
Water (purchased)	value	—	—	—	4,318	—	—	—	187,806
Wood Fuel	value	—	438	—	—	—	11,805	—	14,117
Zinc and Zinc Discs	lb.	1,268	25	—	—	863	26	4,761,483	108,285
Sundry Articles not specified above	value	—	2,982	—	14,081	—	59,350	—	126,646
TOTAL VALUE		—	213,032	—	552,492	—	673,876	—	15,383,601

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		CAPE.				ORANGE FREE STATE.			
		Diamond Mines.		Other Mines.		Diamond Mines.		Coal Mines.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£		£
Bags	value	—	249	—	1,162	—	488	—	128
Belting (including laces and fasteners)	value	—	6,630	—	143	—	2,071	—	705
Boiler Fluid	value	—	—	—	—	—	—	—	—
Bricks, Fireclay, etc.	value	—	2,582	—	61	—	907	—	693
Brushware	value	—	555	—	33	—	197	—	60
Buckets	value	—	145	—	7	—	50	—	81
Building Material (Ceilings, Floorings, Doors, Windows, etc.)	value	—	2,450	—	24	—	1,148	—	150
Candles	lb.	124,233	3,689	50,113	1,503	96,380	1,941	66,380	1,865
Carbide	lb.	56,880	791	3,850	74	47,696	706	36,774	386
Castings—									
(*a*) Brass	value	—	4,301	—	9	—	114	—	180
(*b*) Iron	value	—	13,988	—	—	—	728	—	715
Cement—									
(*a*) Bags	No.	18,183	7,338	125	52	5,744	2,314	1,333	550
(*b*) Casks	No.	3	4	221	334	—	—	—	—
Charcoal	value	—	97	—	10	—	43	—	—
Chemicals, Assay, and Smelting Requisites	value	—	348	—	63	—	81	—	—
Cloth, Canvas, Blanketing, Matting, etc.	value	—	525	—	90	—	26	—	167
Clothing, Boots, and Leggings (*excluding* issues on repayment)	value	—	836	—	—	—	32	—	819
Coal-cutting Machines	No.	—	—	—	—	—	—	—	—
Coal-cutting Machine Spares	value	—	—	—	—	—	—	—	1,303
Coal—									
(*a*) Smithy	tons	6	22	32	194	203	286	4	9
(*b*) Steam	tons	78,419	89,110	967	5,295	54,673	59,763	1,230	307
(*c*) Other	tons	494	1,747	—	—	1,564	1,913	—	—
(*d*) Duff and Dross	tons	—	—	—	—	70	35	—	—
Coke	tons	305	854	7,813	48,748	74	194	—	—
Compressed Air (purchased)	value	—	—	—	—	—	—	—	—
Concrete Pipes, Blocks, etc.	value	—	3,315	—	—	—	—	—	—
Cyanide	lb.	—	—	—	—	—	—	—	—
Disinfectants	value	—	743	—	34	—	220	—	103
Electrical Machinery	value	—	2,831	—	—	—	11,565	—	238
Electrical Machinery Spares and Fittings	value	—	14,651	—	147	—	1,730	—	2,160
Electric Power and Light (purchased)	value	—	—	—	—	—	—	—	—
Explosives—									
(*a*) Blasting Gelatine	cases	—	—	125	390	50	169	—	—
(*b*) Gelignite and Gelatine Dynamite	cases	2,006	3,963	1,660	4,447	1,656	2,928	3,830	7,479
(*c*) Dynamite and Ligdyn	cases	28,588	51,954	517	896	16,589	29,948	—	—
(*d*) Permitted Explosives for Fiery Coal Mines	cases	—	—	—	—	—	—	852	1,559
(*e*) Detonators (excluding Capped Fuses)	value	—	3,838	—	874	—	2,249	—	1,004
(*f*) Electric Detonators (or Electric Fuse)	value	—	—	—	—	—	257	—	805
(*g*) Safety Fuse (excluding Capped Fuses)	value	—	9,919	—	1,380	—	5,490	—	2,469
(*h*) Capped Fuse	value	—	—	—	—	—	121	—	—
(*i*) Lighting Torches (Tyisa Sticks)	value	—	820	—	43	—	278	—	47
Fencing and Wire Netting	value	—	408	—	40	—	31	—	37
Ferodo and other Brake Linings	value	—	—	—	—	—	—	—	10
Fodder for Stables—									
Bran, Chaff, Mealies, Forage, etc.	value	—	7,786	—	983	—	4,537	—	1,191
Food, Coffee, etc. (supplied *free* to white employees)	value	—	—	—	—	—	—	—	—
Foods, etc. (supplied *free* to Coloured Labourers)—									
(*a*) Beans	lb.	29,600	190	—	—	22,125	152	102,998	504
(*b*) Dholl	lb.	—	—	—	—	—	—	—	—
(*c*) Rice	lb.	—	—	—	—	—	—	435	5
(*d*) Meal (Mealie, Kaffir Corn, etc.)	bags	3,781	2,899	1,450	1,122	15,222	12,280	6,636	4,213
(*e*) Malt and Cereals for Beer	value	—	5	—	—	—	449	—	110
(*f*) Meat	lb.	123,180	1,957	8,000	105	692,481	9,165	437,635	4,198
(*g*) Fish	lb.	—	—	—	—	—	—	—	—
(*h*) Salt	bags	271	59	—	—	151	50	128	34
(*i*) Groceries, Coffee, Sugar, Oil, Ghee, Molasses, etc.	value	—	190	—	—	—	381	—	938
(*j*) Sundry Food, including Bread	value	—	932	—	—	—	7,380	—	2,702
(*k*) Vegetables	value	—	503	—	—	—	558	—	1,090

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		Cape.				Orange Free State.			
		Diamond Mines.		Other Mines.		Diamond Mines.		Coal Mines.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£		£
Foundry Requisites	value	—	436	—	53	—	55	—	—
Furniture	value	—	—	—	25	—	1,107	—	—
Glass	value	—	273	—	8	—	39	—	21
Hand Tools (Picks, Shovels, Hammers, etc.)	value	—	3,874	—	367	—	981	—	748
Hose Fittings	value	—	212	—	—	—	19	—	4
Hosing (Steam, Suction Rock-drill, etc.)	value	—	1,342	—	3	—	804	—	370
Hospital and Ambulance Requisites (including Medicines)	value	—	3,075	—	260	—	1,071	—	466
Instruments and Survey Requisites	value	—	9	—	—	—	20	—	167
Iron—									
(*a*) Bar and Angle	lb.	248,602	2,384	23,889	278	129,118	1,533	112,192	1,069
(*b*) Galvanized	value	—	2,042	—	143	—	911	—	71
(*c*) Sheet	lb.	—	—	—	—	200	6	—	—
(*d*) Pig	lb.	316,129	1,302	—	—	43,600	199	—	—
Ironmongery—									
(*a*) Bolts, Nuts, Washers, and Rivets	lb.	292,221	4,613	6,292	130	120,011	2,313	49,508	893
(*b*) Screws and Nails	value	—	818	—	37	—	183	—	155
(*c*) Locks, Hinges, Staples, Chains, etc.	value	—	1,164	—	31	—	104	—	29
(*d*) Other	value	—	678	—	44	—	37	—	31
Lamps and Spares	value	—	2,437	—	13	—	734	—	83
Lead—									
(*a*) Pig	lb.	1,074	13	—	—	267	5	1,038	29
(*b*) Sheet	lb.	767	26	—	—	75	2	102	1
Lime—									
(*a*) White	bags	337	110	78	33	256	94	61	22
(*b*) Blue	bags	39	13	—	—	328	89	438	89
Lubricants—									
(*a*) Oils	gallons	38,768	7,667	5,475	1,256	28,143	5,577	15,281	2,300
(*b*) Grease and Tallows	value	—	10,202	—	133	—	3,790	—	1,451
Lubricators	value	—	169	—	—	—	96	—	20
Machinery and Machine Tools	value	—	30,876	—	5,335	—	21,819	—	1,629
Machinery Spares, other than electrical	value	—	15,068	—	2,067	—	9,640	—	1,984
Mercury	bottles	—	—	—	—	—	—	—	—
Metals (anti-friction)	value	—	1,274	—	11	—	542	—	170
Metals—Other (Bronze, Delta, etc.)	value	—	671	—	16	—	183	—	56
Motor-cars and Accessories	value	—	6,423	—	835	—	257	—	—
Oils, other than lubricating—									
(*a*) Transformer	gallons	294	72	—	—	316	60	—	—
(*b*) Other	gallons	867	296	125,860	7,129	218	80	2,544	432
Oilskin Suits and Gumboots	value	—	227	—	4	—	639	—	4
Oxygen, Acetylene, and Welding Requisites	value	—	192	—	118	—	214	—	41
Packing	value	—	1,266	—	144	—	740	—	419
Paint, Tar, Driers, etc	value	—	2,542	—	215	—	291	—	211
Paraffin	cases	1,009	828	453	368	297	250	40	64
Petrol	gallons	36,079	5,458	7,137	1,019	7,436	1,147	—	—
Pipes and Pipe Fittings	value	—	9,012	—	850	—	4,816	—	979
Rails, Crossings, Sleepers, etc.	value	—	5,522	—	239	—	2,382	—	3,092
Rock-drills	No.	46	1,628	—	—	22	1,165	—	—
Rock-drill Spares	value	—	2,260	—	—	—	1,746	—	—
Ropes—									
(*a*) Wire	value	—	10,094	—	101	—	5,997	—	1,700
(*b*) Vegetable Fibre	value	—	616	—	99	—	250	—	—
Rubber—Valves, Rings, Rollers, etc.	value	—	—	—	—	—	66	—	17
Sand and Stone	value	—	3,839	—	—	—	112	—	25
Screening	value	—	132	—	5	—	357	—	199
Shoes and Dies	lb.	—	—	—	—	1,350	21	—	—
Skips, Cages, Kibbles, and Spares	value	—	422	—	185	—	88	—	5
Soap	lb.	14,696	369	1,340	44	2,736	93	2,311	44
Soda	lb.	10,364	93	—	—	960	20	49	2
Stable Requisites	value	—	56	—	28	—	79	—	117
Stationery and Printing	value	—	4,075	—	176	—	1,351	—	214

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		CAPE.				ORANGE FREE STATE.			
		Diamond Mines.		Other Mines.		Diamond Mines.		Coal Mines.	
		Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.	Weight or Quantity.	Value.
			£		£		£		£
Steel—									
(*a*) Bar, Tool, Cast, etc.	lb.	428,005	4,463	643	19	54,572	963	3,087	114
(*b*) Sheet	lb.	897,009	8,306	21,547	180	306,166	3,107	20,817	196
(*c*) Hand-drill	lb.	3,833	71	18,549	395	2,567	40	316	7
(*d*) Rock-drill	lb.	84,875	1,905	—	—	47,095	1,045	10,513	365
(*e*) Structural	value	—	—	—	—	—	—	—	8
(*f*) Other	lb.	205,176	1,766	—	—	83,055	840	6,832	38
Tamping (Plugs, Paper, etc.)	value	—	121	—	—	—	10	—	172
Timber—									
(*a*) Deals	value	—	1,341	—	515	—	3,508	—	319
(*b*) Oregon, Pitch Pine, etc.	value	—	10,835	—	29	—	4,663	—	162
(*c*) Mining Poles and Lagging	value	—	16,167	—	134	—	2,461	—	787
(*d*) Other	value	—	1,179	—	285	—	65	—	455
Transport, Railage, etc.	value	—	1,156	—	—	—	14,175	—	567
Tube Mill Requisites—									
(*a*) Pebbles and Flints	value	—	—	—	—	—	—	—	—
(*b*) Liners	value	—	131	—	590	—	—	—	—
(*c*) Other Requisites	value	—	65	—	—	—	—	—	—
Trucks and Spares	value	—	6,661	—	1,951	—	2,436	—	786
Waste, Sweat Rags, etc.	value	—	1,079	—	75	—	488	—	208
Water (purchased)	value	—	14,103	—	—	—	4,975	—	—
Wood Fuel	value	—	11,596	—	4,030	—	120	—	—
Zinc and Zinc Discs	lb.	1,500	49	—	—	1,125	26	100	3
Sundry Articles not specified above	value	—	13,229	—	7,513	—	8,506	—	692
TOTAL VALUE		—	**483,617**	—	**105,781**	—	**284,577**	—	**63,316**

Classification.		NATAL.				TOTALS.			
		Coal Mines.		*South African (including Rhodesian) Products.*		*Imported.*		Total.	
		Weight or Quantity.	Value.	*Weight or Quantity.*	*Value.*	*Weight or Quantity.*	*Value.*	Weight or Quantity.	Value
			£		£		£		£
Bags	value	—	3,548	—	*4,632*	—	*16,731*	—	21,363
Belting (including laces and fasteners)	value	—	4,100	—	*205*	—	*150,474*	—	150,679
Boiler Fluid	value	—	477	—	*3,152*	—	*2,696*	—	5,848
Bricks, Fireclay, etc.	value	—	10,110	—	*50,841*	—	*4,760*	—	55,601
Brushware	value	—	501	—	*7,348*	—	*7,209*	—	14,557
Buckets	value	—	409	—	*1,891*	—	*5,293*	—	7,184
Building Material (Ceilings, Floorings, Doors, Windows, etc.)	value	—	9,846	—	*12,194*	—	*36,760*	—	48,954
Candles	lb.	218,565	6,352	*6,900,407*	*185,890*	—	—	6,900,407	185,890
Carbide	lb.	74,025	923	*9,693,397*	*108,122*	*105,192*	*1,650*	9,798,589	109,772
Castings—									
(*a*) Brass	value	—	1,150	—	*49,526*	—	—	—	49,526
(*b*) Iron	value	—	1,613	—	*212,437*	—	—	—	212,437
Cement—									
(*a*) Bags	No.	18,916	7,482	*509,991*	*200,279*	—	—	509,991	200,279
(*b*) Casks	No.	8	37	—	—	*239*	*399*	239	399
Charcoal	value	—	—	—	*2,346*	—	*2*	—	2,348
Chemicals, Assay, and Smelting Requisites	value	—	693	—	*83,440*	—	*75,446*	—	158,886
Cloth, Canvas, Blanketing, Matting, etc.	value	—	7,530	—	*8,878*	—	*40,722*	—	49,600
Clothing, Boots, and Leggings (*excluding* issues on repayment)	value	—	73	—	*14,546*	—	*6,925*	—	21,471
Coal-cutting Machines	No.	14	7,894	—	—	*60*	*14,708*	60	14,708
Coal-cutting Machine Spares	value	—	12,081	—	*2,025*	—	*23,132*	—	25,157
Coal—									
(*a*) Smithy	tons	822	251	*37,524*	*27,267*	*7*	*72*	37,531	27,339
(*b*) Steam	tons	12,130	2,810	*1,677,103*	*1,080,771*	—	—	1,677,103	1,080,771
(*c*) Other	tons	721	200	*91,957*	*49,056*	—	—	91,957	49,056
(*d*) Duff and Dross	tons	115,597	12,359	*357,206*	*142,515*	—	—	357,206	142,515

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		NATAL.		TOTALS.					
		Coal Mines.		*South African (including Rhodesian) Products.*		*Imported.*		Total.	
		Weight or Quantity.	Value.	*Weight or Quantity.*	*Value.*	*Weight or Quantity.*	*Value.*	Weight or Quantity.	Value.
			£		£		£		£
Coke	tons	—	—	*10,195*	*55,559*	*32*	*282*	10,227	55,841
Compressed Air (purchased)	value	—	—	—	*385,348*	—	—	—	385,348
Concrete Pipes, Blocks, etc	value	—	29	—	*29,754*	—	—	—	29,754
Cyanide	lb.	—	—	—	—	*9,567,807*	*310,239*	9,567,807	310,239
Disinfectants	value	—	1,184	—	*2,636*	—	*15,533*	—	18,169
Electrical Machinery	value	—	21,928	—	*3,447*	—	*619,028*	—	622,475
Electrical Machinery Spares and Fittings	value	—	8,169	—	*5,816*	—	*136,747*	—	142,563
Electric Power and Light (puchased)	value	—	632	—	*1,620,799*	—	—	—	1,620,799
Explosives—									
(*a*) Blasting Gelatine	cases	15	46	*10,014*	*28,353*	—	—	10,014	28,353
(*b*) Gelignite and Gelatine Dynamite	cases	2,537	6,648	*768,293*	*1,466,239*	—	—	768,293	1,466,239
(*c*) Dynamite and Ligdyn	cases	7,052	11,856	*105,209*	*169,072*	—	—	105,209	169,072
(*d*) Permitted Explosives for Fiery Coal Mines	cases	9,571	26,117	*18,531*	*40,115*	*74*	*210*	18,605	40,325
(*e*) Detonators (excluding Capped Fuses)	value	—	2,336	—	*23,198*	—	*23,596*	—	46,794
(*f*) Electric Detonators (or Electric Fuse)	value	—	14,866	—	*16,879*	—	*6,634*	—	23,513
(*g*) Safety Fuse (excluding Capped Fuses)	value	—	4,844	—	—	—	*132,932*	—	132,932
(*h*) Capped Fuse	value	—	79	—	*99,957*	—	*192,364*	—	292,321
(*i*) Lighting Torches (Tyisa Sticks)	value	—	13	—	*17,102*	—	*89*	—	17,191
Fencing and Wire Netting	value	—	703	—	*628*	—	*6,903*	—	7,531
Ferodo and other Brake Linings	value	—	201	—	*112*	—	*1,969*	—	2,081
Fodder for Stables—									
Bran, Chaff, Mealies, Forage, etc.	value	—	1,911	—	*55,371*	—	—	—	55,371
Food, Coffee, etc. (supplied *free* to white employees)	value	—	—	—	*7,745*	—	*3,587*	—	11,332
Foods, etc. (supplied *free* to Coloured Labourers)—									
(*a*) Beans	lb.	292,116	1,703	*7,969,553*	*42,394*	—	—	7,969,553	42,394
(*b*) Dholl	lb.	80,227	790	—	—	*80,227*	*790*	80,227	790
(*c*) Rice	lb.	967,052	11,099	—	—	*1,687,449*	*19,988*	1,687,449	19,988
(*d*) Meal (Mealie, Kaffir Corn, etc.)	bags	96,421	67,547	*843,725*	*573,719*	—	—	843,725	573,719
(*e*) Malt and Cereals for Beer	value	—	3,651	—	*34,211*	—	—	—	34,211
(*f*) Meat	lb.	2,169,859	29,621	*42,868,000*	*436,961*	—	—	42,868,000	436,961
(*g*) Fish	lb.	—	—	*991,055*	*14,878*	—	—	991,055	14,878
(*h*) Salt	bags	1,624	526	*11,761*	*3,598*	—	—	11,761	3,598
(*i*) Groceries, Coffee, Sugar, Oil, Ghee, Molasses, etc	value	—	2,127	—	*44,521*	—	*6,778*	—	51,299
(*j*) Sundry Food, including Bread	value	—	1,412	—	*212,255*	—	*321*	—	212,576
(*k*) Vegetables	value	—	6,105	—	*72,596*	—	—	—	72,596
Foundry Requisites	value	—	143	—	*202*	—	*1,568*	—	1,770
Furniture	value	—	409	—	*2,315*	—	*7,879*	—	10,194
Glass	value	—	485	—	*34*	—	*3,006*	—	3,040
Hand Tools (Picks, Shovels Hammers, etc.)	value	—	6,135	—	*5,008*	—	*124,483*	—	129,491
Hose Fittings	value	—	126	—	*34,659*	—	*12,570*	—	47,229
Hosing (Steam, Suction, Rock-drill, etc.)	value	—	589	—	*29,897*	—	*93,494*	—	123,391
Hospital and Ambulance Requisites (including Medicines)	value	—	2,377	—	*13,020*	—	*57,299*	—	70,319
Instruments and Survey Requisites	value	—	79	—	*1,709*	—	*10,263*	—	11,972
Iron—									
(*a*) Bar and Angle	lb.	366,657	3,461	*6,449,757*	*63,252*	*4,306,518*	*47,340*	10,756,275	110,592
(*b*) Galvanized	value	—	1,588	—	—	—	*34,199*	—	34,199
(*c*) Sheet	lb.	17,620	302	*9,383*	*89*	*399,394*	*5,347*	408,777	5,436
(*d*) Pig	lb.	—	—	*502,959*	*1,590*	*463,403*	*2,010*	966,362	3,600
Ironmongery—									
(*a*) Bolts, Nuts, Washers, and Rivets	lb.	202,949	2,979	*612,978*	*9,249*	*4,080,419*	*69,896*	4,693,397	79,145
(*b*) Screws and Nails	value	—	895	—	*9,830*	—	*10,202*	—	20,032
(*c*) Locks, Hinges, Staples, Chains, etc	value	—	505	—	*293*	—	*17,465*	—	17,758
(*d*) Other	value	—	575	—	*14,417*	—	*11,998*	—	26,415
Lamps and Spares	value	—	8,791	—	*4,542*	—	*21,518*	—	26,060
Lead—									
(*a*) Pig	lb.	2,586	61	*162,198*	*2,136*	*41,959*	*822*	204,157	2,958
(*b*) Sheet	lb.	5,986	146	*766*	*29*	*21,894*	*611*	22,660	640
Lime—									
(*a*) White	bags	2,278	507	*700,971*	*160,080*	—	—	700,971	160,080
(*b*) Blue	bags	4,112	1,009	*37,713*	*7,537*	—	—	37,713	7,537

STORES CONSUMED BY THE MINES DURING THE YEAR 1926 (*continued*).

Classification.		NATAL.		TOTALS.					
		Coal Mines.		*South African (including Rhodesian) Products.*		*Imported.*		Total.	
		Weight or Quantity.	Value.	*Weight or Quantity.*	*Value.*	*Weight or Quantity.*	*Value.*	Weight or Quantity	Value.
			£		£		£		£
Lubricants—									
(*a*) Oils	gallons	84,114	13,190	*7,157*	*1,761*	*748,370*	*139,436*	755,527	141,197
(*b*) Grease and Tallows	value	—	10,561	—	*80,100*	—	*57,950*	—	138,050
Lubricators	value	—	142	—	*2,174*	—	*3,760*	—	5,934
Machinery and Machine Tools	value	—	19,557	—	*43,007*	—	*589,283*	—	632,290
Machinery Spares, other than electrical	value	—	12,752	—	*91,246*	—	*370,664*	—	461,910
Mercury	bottles	—	—	—	—	*895*	*13,825*	895	13,825
Metals (anti-friction)	value	—	538	—	*4,084*	—	*23,567*	—	27,651
Metals—Other (Bronze, Delta, etc.)	value	—	206	—	*983*	—	*11,758*	—	12,741
Motor-cars and Accessories	value	—	2,554	—	*1,355*	—	*27,360*	—	28,715
Oils, other than lubricating—									
(*a*) Transformer	gallons	500	133	—	—	*16,560*	*3,758*	16,560	3,758
(*b*) Other	gallons	38,060	3,814	*9,116*	*890*	*356,471*	*24,714*	365,587	25,604
Oilskin Suits and Gumboots	value	—	131	—	*83*	—	*23,326*	—	23,409
Oxygen, Acetylene, and Welding Requisites	value	—	139	—	*13,888*	—	*1,757*	—	15,645
Packing	value	—	1,627	—	*11,669*	—	*42,255*	—	53,924
Paint, Tar, Driers, etc.	value	—	2,106	—	*6,124*	—	*36,359*	—	42,483
Paraffin	cases	833	643	—	—	*19,052*	*15,219*	19,052	15,219
Petrol	gallons	15,504	2,330	*1,335*	*162*	*335,381*	*52,538*	336,716	52,700
Pipes and Pipe Fittings	value	—	12,668	—	*42,106*	—	*490,661*	—	532,767
Rails, Crossings, Sleepers, etc.	value	—	41,750	—	*211,678*	—	*183,262*	—	394,940
Rock-drills	No.	2	109	*16*	*750*	*2,020*	*107,598*	2,032	108,348
Rock-drill Spares	value	—	829	—	*150,921*	—	*317,977*	—	468,898
Ropes—									
(*a*) Wire	value	—	17,947	—	*133,142*	—	*122,986*	—	256,128
(*b*) Vegetable Fibre	value	—	288	—	*5,229*	—	*6,294*	—	11,523
Rubber—Valves, Rings, Rollers etc.	value	—	63	—	*3,990*	—	*2,854*	—	6,844
Sand and Stone	value	—	1,839	—	*37,489*	—	—	—	37,489
Screening	value	—	679	—	*7,423*	—	*12,130*	—	19,553
Shoes and Dies	lb.	—	—	*12,476,804*	*94,039*	984,701	*11,212*	13,461,505	105,251
Skips, Cages, Kibbles, and Spares	value	—	2	—	*9,987*	—	*10,004*	—	19,991
Soap	lb.	32,484	637	*655,864*	*13,562*	*20,662*	*468*	676,526	14,030
Soda	lb.	8,332	99	*2,507,559*	*12,390*	*378,496*	*3,437*	2,886,055	15,827
Stable Requisites	value	—	336	—	*7,754*	—	*2,901*	—	10,655
Stationery and Printing	value	—	4,461	—	*63,994*	—	*26,793*	—	90,787
Steel—									
(*a*) Bar, Tool, Cast, etc.	lb.	124,319	1,323	*872,301*	*8,159*	*2,159,127*	*40,058*	3,031,428	48,217
(*b*) Sheet	lb.	315,929	2,852	*21,039*	*105*	*16,774,601*	*137,927*	16,795,640	138,032
(*c*) Hand-drill	lb.	9,955	201	—	—	*1,171,817*	*17,330*	1,171,817	17,330
(*d*) Rock-drill	lb.	14,284	385	—	—	*13,204,052*	*309,405*	13,204,052	309,405
(*e*) Structural	value	—	565	—	*7,901*	—	*22,438*	—	30,339
(*f*) Other	lb.	21,039	382	*661,846*	*7,025*	*824,091*	*9,351*	1,485,937	16,376
Tamping (Plugs, Paper, etc.)	value	—	—	—	*11,854*	—	*445*	—	12,299
Timber—									
(*a*) Deals	value	—	3,689	—	*621*	—	*110,160*	—	110,781
(*b*) Oregon, Pitch Pine, etc.	value	—	4,233	—	*9,305*	—	*289,015*	—	298,320
(*c*) Mining Poles and Lagging	value	—	26,447	—	*662,058*	—	—	—	662,058
(*d*) Other	value	—	2,112	—	*47,818*	—	*19,955*	—	67,773
Transport, Railage, etc.	value	—	3,147	—	*64,377*	—	—	—	64,377
Tube Mill Requisites—									
(*a*) Pebbles and Flints	value	—	—	—	*52*	—	—	—	52
(*b*) Liners	value	—	—	—	*118,504*	—	*4,738*	—	123,242
(*c*) Other Requisites	value	—	—	—	*10,507*	—	*7,842*	—	18,349
Trucks and Spares	value	—	12,051	—	*36,355*	—	*152,510*	—	188,865
Waste, Sweat Rags, etc.	value	—	1,026	—	*638*	—	*15,493*	—	16,131
Water (purchased)	value	—	25	—	*206,909*	—	—	—	206,909
Wood Fuel	value	—	—	—	*29,863*	—	—	—	29,863
Zinc and Zinc Discs	lb.	917	23	—	—	*4,765,125*	*108,386*	4,765,125	108,386
Sundry Articles not specified above	value	—	11,275	—	*82,573*	—	*85,288*	—	167,861
TOTAL VALUE		—	569,610	—	10,427,116	—	6,463,386	—	16,890,502

DETAILED STATEMENT OF "MACHINERY AND TOOLS" AND "ELECTRICAL MACHINERY," YEAR 1926, AS SHOWN (GROSS) IN TABLE I.

Classification.	TRANSVAAL.						
	Gold Mines (Large).			Diamond Mines.	Coal Mines.	Other Mines.	Totals Transvaal Mines.
	Witwatersrand.	Outside Witwatersrand.	Totals.				
	£	£	£	£	£	£	£
MACHINERY AND MACHINE TOOLS.							
Water Purifiers	98	—	98	—	—	—	98
Boiler Plant, other than that of Locomotives, Traction Engines, or Steam Wagons	32,926	800	33,726	—	2,144	5,819	41,689
Headgear	6,486	—	6,486	—	—	486	6,972
Steam Engines—							
(a) For Winding	11,061	—	11,061	—	—	1,077	12,138
(b) For Pumping, including Pumps if directly driven	126	—	126	—	181	—	307
(c) For Compressors, including Compressors	37,000	400	37,400	734	2,306	4,021	44,461
(d) For Generating Electricity	—	352	352	—	372	285	1,009
(e) For other purposes	200	—	200	—	112	—	312
Pumps—							
(a) Air-driven	5,097	37	5,134	—	492	1,628	7,254
(b) Driven indirectly by Steam	3,889	147	4,036	—	15	597	4,648
(c) Driven indirectly by Electric Motors	24,157	2,887	27,044	166	1,251	2,523	30,984
(d) Driven indirectly by Gas or Oil Engine	—	—	—	—	—	131	131
Steam Locomotives	—	1,370	1,370	—	5,422	—	6,792
Traction Engines	1,018	—	1,018	—	—	—	1,018
Steam Lorries	1,680	—	1,680	—	—	—	1,680
Motor Wagons—							
(a) Electric	620	—	620	—	—	—	620
(b) Oil	2,396	1,485	3,881	—	—	—	3,881
Gas or Oil Engines	25	—	25	—	—	10,357	10,382
Mechanical Lifts and Elevators, other than Belt Conveyors and Elevators	10,871	5,070	15,941	150	—	2,312	18,403
Belt Conveyors and Elevators	6,225	506	6,731	4,736	2,434	2,065	15,966
Other Mechanical Haulage	17,382	10	17,392	—	1,398	6,219	25,009
Reduction Plant, excluding Engines and Consumable Stores, such as Shoes and Dies, Screenings, etc.	40,810	38,527	79,337	—	163	21,726	101,226
Washing Plant	1,932	—	1,932	—	—	100	2,032
Treatment Plant, including Furnaces	818	—	818	—	100	5,484	6,402
Workshops Plant, excluding Engines and Motors	47,153	6,221	53,374	—	1,390	4,778	59,542
Mine Ventilation Plant, excluding Engines, Compressors, and Motors	11,770	460	12,230	—	319	276	12,825
Diamond Drills (property of company)	—	—	—	—	125	—	125
Miscellaneous Machinery not particularized above	68,439	9,034	77,473	3,962	9,097	46,636	137,168
TOTAL VALUE [shown under the Heading "Machinery and Machine Tools" (Stores Consumed)]....£	332,179	67,306	399,485	9,748	27,321	116,520	553,074
ELECTRICAL MACHINERY, INCLUDING FITTINGS FOR POWER AND LIGHTING.							
Electric Generators and Engines driving same if directly driven	25,222	—	25,222	—	3,589	23,271	52,082
Electric Hoists, including Motors	172,917	701	173,618	—	426	4,925	178,969
Electric Locomotives	25,786	56	25,842	—	—	—	25,842
Electric Motors driving Pumps, including Pumps if directly driven	34,569	453	35,022	1,132	1,232	3,160	40,546
Electric Motors not included above	35,365	7,010	42,375	505	3,964	6,071	52,915
Power Lines, Transformers, etc.	144,548	5,136	149,684	219	5,931	7,789	163,623
Electric Bells, Telephones, and other Fixtures	30,663	2,094	32,757	—	2,667	1,397	36,821
Miscellaneous Machinery not particularized above	32,008	799	32,807	—	1,670	638	35,115
TOTAL VALUE [shown under the heading "Electrical Machinery" (Stores Consumed)]....£	501,078	16,249	517,327	1,856	19,479	47,251	585,913

DETAILED STATEMENT OF "MACHINERY AND TOOLS" AND "ELECTRICAL MACHINERY," YEAR 1926, AS SHOWN (GROSS) IN TABLE I (*continued*).

Classification.	Cape.		Orange Free State.		Natal.	Union of South Africa.
	Diamond Mines.	Other Mines.	Diamond Mines.	Coal Mines.	Coal Mines.	Total.
MACHINERY AND MACHINE TOOLS.	£	£	£	£	£	£
Water Purifiers	—	—	—	—	—	98
Boiler Plant, other than that of Locomotives, Traction Engines, or Steam Wagons	732	—	1,886	20	3,831	48,158
Headgear	6,953	—	—	—	4,360	18,285
Steam Engines—						
(*a*) For Winding	—	—	550	—	—	12,688
(*b*) For Pumping, including Pumps if directly driven	—	—	—	—	—	307
(*c*) For Compressors, including Compressors	—	—	3,358	—	—	47,819
(*d*) For Generating Electricity	—	—	367	—	—	1,376
(*e*) For other purposes	—	—	—	152	165	629
Pumps—						
(*a*) Air-driven	—	—	—	—	131	7,385
(*b*) Driven indirectly by Steam	—	—	429	—	436	5,513
(*c*) Driven indirectly by Electric Motors	397	—	78	—	183	31,642
(*d*) Driven indirectly by Gas or Oil Engine	—	—	—	—	—	131
Steam Locomotives	—	—	—	—	2,400	9,192
Traction Engines	—	—	—	—	—	1,018
Steam Lorries	—	—	—	—	—	1,680
Motor Wagons—						
(*a*) Electric	—	—	—	—	—	620
(*b*) Oil	—	—	—	—	—	3,881
Gas or Oil Engines	3,810	—	274	—	—	14,466
Mechanical Lifts and Elevators, other than Belt Conveyors and Elevators	185	—	—	—	138	18,726
Belt Conveyors and Elevators	—	—	—	—	296	16,262
Other Mechanical Haulage	1,634	—	434	70	952	28,099
Reduction Plant, excluding Engines and Consumable Stores, such as Shoes and Dies, Screenings, etc.	—	—	—	—	—	101,226
Washing Plant	5,633	—	1,939	—	100	9,704
Treatment Plant, including Furnaces	—	—	—	—	—	6,402
Workshops Plant, excluding Engines and Motors	1,445	—	126	—	560	61,673
Mine Ventilation Plant, excluding Engines, Compressors, and Motors	—	—	—	1,182	32	14,039
Diamond Drills (property of company)	—	—	—	—	—	125
Miscellaneous Machinery not particularized above	10,087	5,335	12,378	205	5,973	171,146
TOTAL VALUE [shown under the heading "Machinery and Machine Tools" (Stores Consumed)].....£	30,876	5,335	21,819	1,629	19,557	632,290
ELECTRICAL MACHINERY, INCLUDING FITTINGS FOR POWER AND LIGHTING.						
Electric Generators and Engines driving same if directly driven	572	—	2,295	—	5,285	60,234
Electric Hoists, including Motors	300	—	492	—	—	179,761
Electric Locomotives	—	—	—	—	—	25,842
Electric Motors driving Pumps, including Pumps if directly driven	200	—	1,629	—	1,310	43,685
Electric Motors not included above	825	—	2,984	3	2,517	59,244
Power Lines, Transformers, etc	422	—	3,156	—	10,743	177,944
Electric Bells, Telephones, and other Fixtures	450	—	51	11	117	37,450
Miscellaneous Machinery not particularized above	62	—	958	224	1,956	38,315
TOTAL VALUE [shown under the heading "Electrical Machinery" (Stores Consumed)].....£	2,831	—	11,565	238	21,928	622,475

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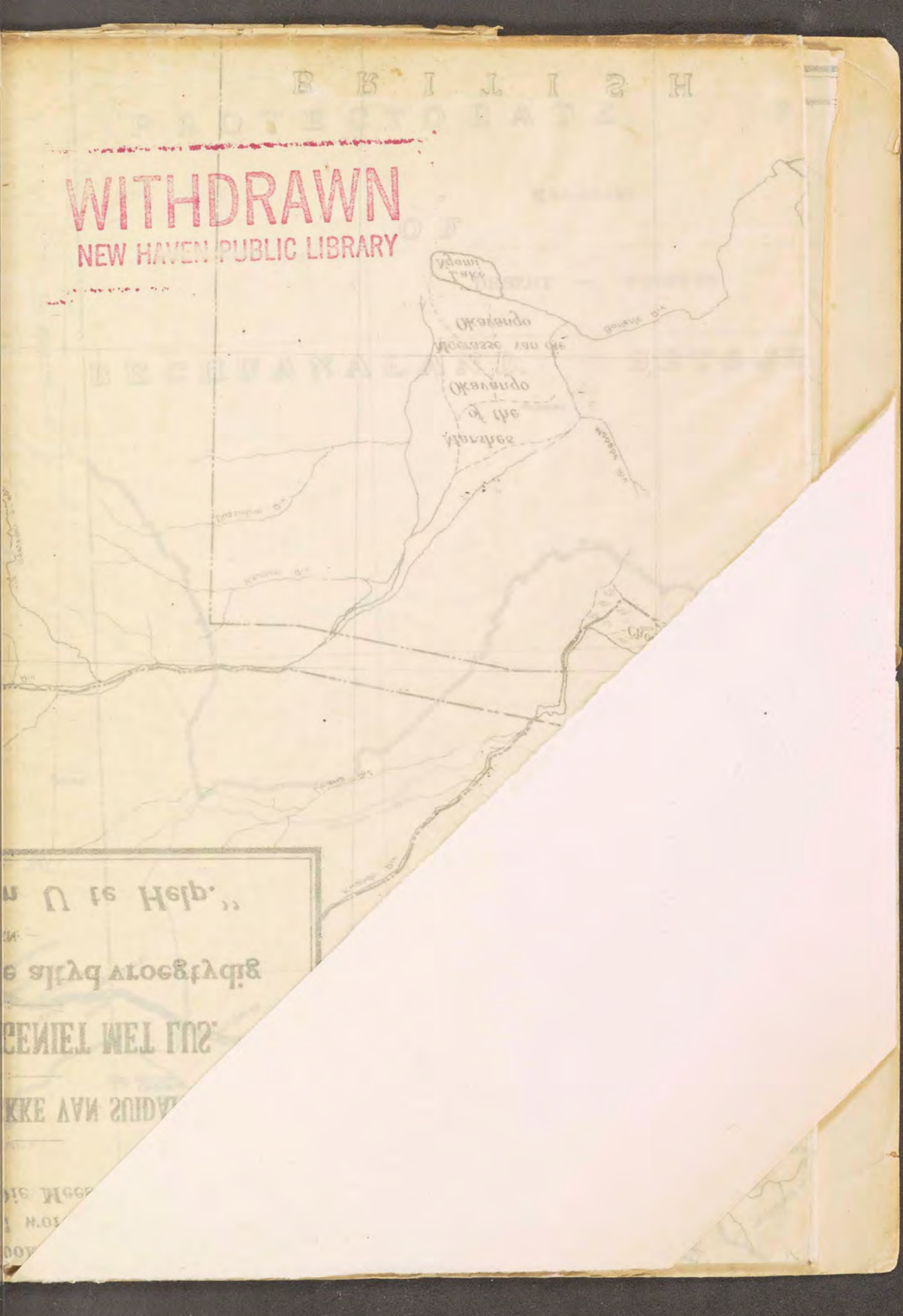

STANDARD RAILWAY MAP OF SOUTH AFRICA

STANDAARD SPOORWEGKAART VAN SUIDAFRIKA

Miles 50 0 50 100 150 200 Myle

— SCALE — 1 in 3,500,000 — SKAAL —

REFERENCE.

SOUTH AFRICAN RAILWAYS	3' 6" gauge (spoorwydte)
	2' 0" " "
RHODESIA RAILWAYS, LTD.	
BEIRA AND MASHONALAND RAILWAYS	
CAMINHO DE FERRO DE LOURENCO MARQUES	
PORTUGUESE EAST AFRICA	
BELGIAN CONGO	
PRIVATE RAILWAYS	
LINES PROJECTED OR UNDER CONSTRUCTION	
ROAD MOTOR SERVICES	
For legibility only a few Sidings are shown, thus	

VERWYSING.

SUIDAFRIKAANSE SPOORWEE	
RHODESIE SPOORWEE, BEPK.	
BEIRA EN MASJONALAND SPOORWEG	
CAMINHO DE FERRO DE LOURENCO MARQUES	
PORTUGEES OOS-AFRIKA	
BELGIESE KONGO	
PRIVATE SPOORWEE	
LYNE ONTWERP OF IN AANBOU	
WEGMOTORDIENSTE	
Leesbaarheidshalwe word maar enkele sylyne aangetoon aldus,	

NOTE.—RHODESIA RAILWAYS, LTD.
The section from Vryburg to Bulawayo, with branches, is administered by the SOUTH AFRICAN RAILWAYS. The remainder of the system is administered by the BEIRA AND MASHONALAND RAILWAYS, LTD.

LET WEL.—RHODESIE SPOORWEE, BEPK.
Die afdeling van Vryburg na Bulawayo, met vertakkinge, word geadministreer deur die SUIDAFRIKAANSE SPOORWEE. Die orige gedeelte van die sisteem word geadministreer deur die BEIRA EN MASJONALAND SPOORWEE, BEPK.

SEE AND KNOW YOUR OWN COUNTRY FIRST

Ask your nearest Station Master regarding EXCURSION and SEASIDE TICKETS; also TOURING TRAINS run on basis of Maximum Enjoyment at Minimum Cost.

VISIT THE BEAUTY SPOTS OF SOUTH AFRICA.

TRAVEL WITHOUT TROUBLE.

Book early on all occasions
— AND —
"Help Us to Help You."

SIEN EN KEN U EIE LAND EERS

Vra u naaste Stasiemeester besonderhede omtrent EKSKURSIE- en SEEKUSKAARTJIES; en ook omtrent TOERTREINE, wat gereel word op die grondslag van die leus "Die Meeste Plesier vir die Minste Geld."

BESOEK DIE MOOI PLEKKE VAN SUIDAFRIKA.

REIS MET RUS — GENIET MET LUS.

Bespreek u plekke altyd vroegtydig
— EN —
"Help Ons om U te Help."

PORT ELIZABETH AND ENVIRONS. OMSTREKE.

CAPETOWN—KAAPSTAD AND ENVIRONS.—EN OMSTREKE.

EAST LONDON—OOS LONDEN AND ENVIRONS.—OMSTREKE.

JOHANNESBURG—PRETORIA AND ENVIRONS.—EN OMSTREKE.

DURBAN—PIETERMARITZBURG AND ENVIRONS.—EN OMSTREKE.

Photo-lithographed at the Government Printing Works, Pretoria.
Gefotolitografeer by die Goewermentsdrukkery, Pretoria.

Compiled on the basis of Bonne's projection (Central meridian 25° East Longitude).
Saamgestel op grond van Bonne se ontwerp (Middel meridiaan 25° Oosterlengte).

Drawn in the office of the Chief Civil Engineer, S.A.R., Johannesburg.
Geteken in die Kantoor van die Hoof-Siviele Ingenieur, S.A.S., Johannesburg.